Coronado Bridge
Bicycle/pedestrian tube Feasibility Study

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Prepared by:
HNTB

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Executive Summary

The Coronado Bridge was completed on August 3, 1969, during the celebration of the 200th anniversary of the founding of the City of San Diego. The Bridge is recognized as a landmark and symbol for San Diego and provides connectivity across the San Diego Bay for both the cities of San Diego and Coronado. The Coronado Bridge is noted among world's greatest bridges for the number of and size of its concrete towers. There are 30 towers with the tallest over the navigational channel reaching the height of 200 feet, and were designed with a curved cap to echo the mission arch shape associated with San Diego's regional mission-style architecture.

The bridge is for vehicular purposes, with the exception of special running, walking, and cycling events. Lew Dominy, founder and architect of domusstudio architecture, had a vision to provide a unique share-used path to the Coronado Bridge. His concept for this new shared–used path was to create a tubular structure that is placed within the mission arch of the concrete towers under the steel girders, and place it on either side of the roadway deck at the main spans over the navigational channel. The desire for this concept is to have the structure be integral to the existing bridge and not drastically alter the aesthetic appearance of the existing award winning bridge.

The County of San Diego partnered with the San Diego Association of Governments (SANDAG) and domusstudio architecture, via a "Neighborhood Investment Program" grant to commission the HNTB Corporation to prepare a conceptual level review and assessment of the potential construction of a structural tube for bicycle and pedestrian travel along the Coronado Bridge. The objective of the study is to complete a high-level, fatal flaw assessment of bicycle/pedestrian structural tube alternatives, structural assessment and constructability of their attachment to the Coronado Bridge.

Alignment Assessment

The Team identified three potential alignment alternatives that could potentially accommodate a tube bicycle/pedestrian structure at various locations on the existing bridge structure – under the pier archway, alongside the pier caps and adjacent to the bridge deck (see Figure ES 1). Each of the identified alignments presents challenges. The high-level assessment of the alignment alternatives and the major challenges of each alignment is summarized below:

- Pier Archway – The initial concept was developed to take advantage of the center archways of the bridge pier in order to preserve the architectural and aesthetic principals of this iconic bridge. The initial concept is for a tube-type structure to be located primarily within the center archway of the Coronado Bridge piers and also provide users with the opportunity to enjoy the commanding views that the structure would provide. In order to provide observation decks on the north and south side of the bridge, the facility would swing out from under the center arch, transitioning the alignment to the southern side of the bridge, and then transition back to the northern side of the bridge. The Pier Archway alignment is able to maintain the ADA grade requirements of 5 percent grade or less within the pier archway location for a majority of the bridge span. However, maintaining the 5 percent grade results in the alignment infringing on the navigational channel, with the structure being located below the required 197.12 foot clearance (Appendix A – Department of the Navy response).

- Pier Cap – The pier cap alignment option would locate the potential bicycle/pedestrian facility at the approximate level of the bridge pier caps. This option would only allow a viewing platform on one side of the bridge and would also conflict with the existing traveler system used to maintain the bridge. This would require a new traveler maintenance system to be designed and constructed.

- Bridge Deck – The third alignment identified by The Team placed the bicycle/pedestrian facility alongside the roadway bridge deck. Like the pier cap location, this alignment could be placed on the north or south side of the bridge, only allowing a viewing platform on one side. While this alignment alternative is expected to provide the easiest touchdown connection opportunities, placement of the structure adjacent to the bridge deck would obstruct views of motorists on the bridge and may impact the overall aesthetics of this iconic bridge.

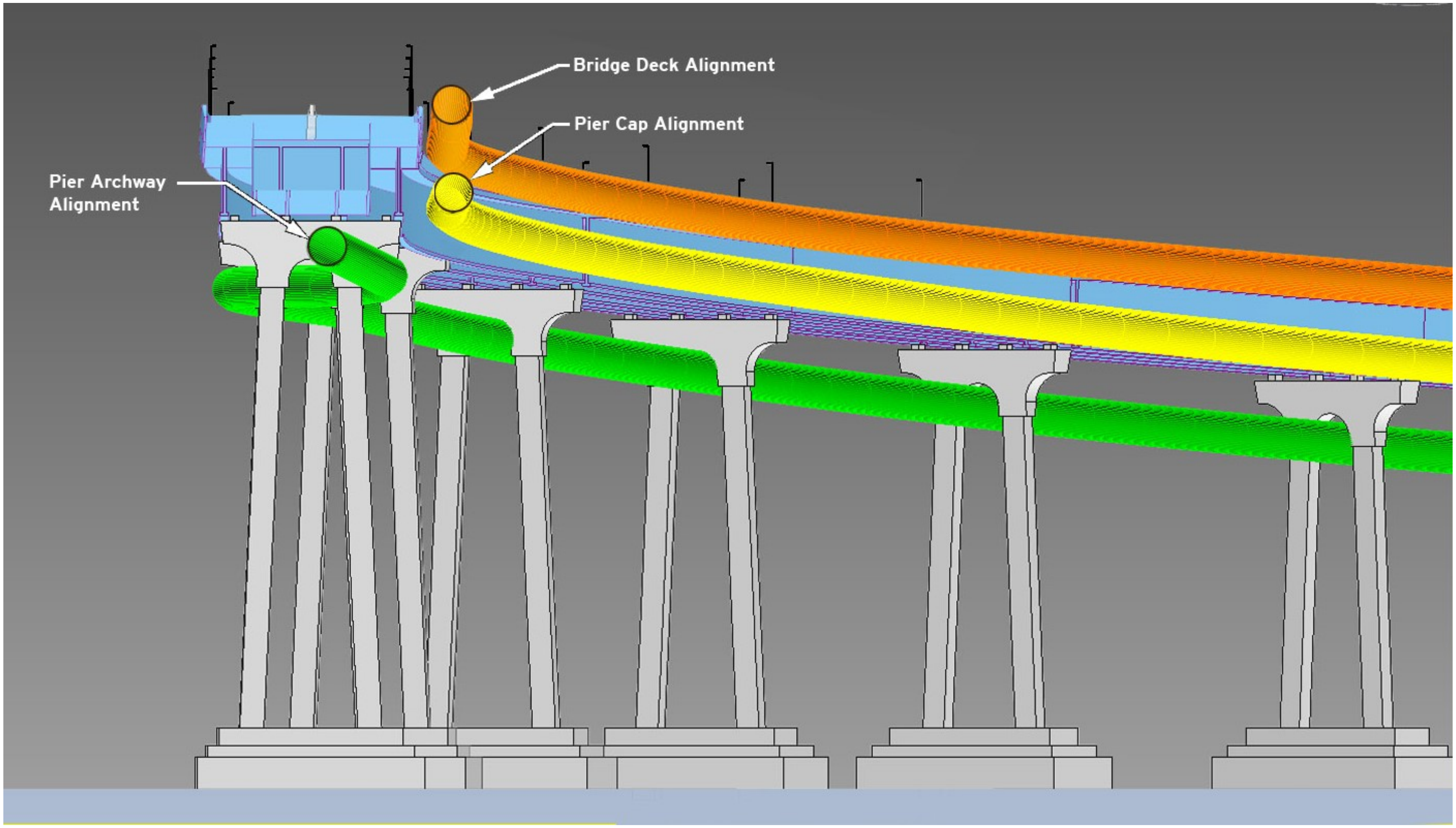

Figure ES 1 – Alignment Alternatives Relative to the Existing Coronado Bay Bridge Structure

Structural Assessment

The high-level analysis completed to assess the structural feasibility of accommodating the proposed bicycle/pedestrian facility on the existing Coronado Bay Bridge indicated that the concept appears feasible. However, as with the geometry and alignment, while there were no identified fatal flaws, there are challenges associated with adding the proposed facility – structural composition of the tube concept, connection to and support of the facility from the existing bridge, and interaction of the two structures for static and transitory loadings (thermal, seismic, wind, dead and live loads).

While the identified challenges are not considered to be fatal flaws or insurmountable, they do require additional study to fully vet the structural concept and identify strengthening measures required to accommodate the final structural configuration and facility alignment.

Constructability and Rough-Order-of-Magnitude Cost Opinion

No fatal flaws were identified for constructability, but there are challenges associated with the construction of the proposed facility. The diverse span arrangement of the bridge influences the construction approach. The required over-water construction (a majority of which at a considerable height), as well as the need to maintain/address the navigation needs and requirements of the U.S. Navy, U.S. Coast Guard, and the Port of San Diego complicates construction of the conceptual facility. All of these considerations present a complex construction environment that requires further analysis to adequately identify the necessary construction approaches (potential means and methods).

The Team developed a high-level, conceptual cost opinion based on a number of relevant factors, such as contractor means and methods, industry per square foot costs, and costs considered typical for both standard and exotic bridge spans. Taking into account the existing bridge and proposed structure complexity, community expectation, programmatic costs and other unknown factors at this juncture–a high-level, ROM opinion of total capital expenditure to construct the proposed bicycle/pedestrian structure is between $185 and $210 million.

Next Steps

While this study evaluated a specific bicycle pedestrian concept (tube structure) the next step would be to initiate additional high-level planning studies to define the purpose and need, identify and assess a wide-range of crossing methods and technologies, environmental and permitting requirements, undertake additional structural analysis, and assess safety, operational and maintenance considerations associated with the potential facility structure (Appendix B Caltrans response). An initial review and assessment of funding sources would identify the range of potential funding options available via federal, state, and local programs, identify potential private grants, programs or donor sources, and assess the potential of the facility to self-fund certain cost components, such as maintenance, through the use of tolls. The Coronado Bridge Suicide Prevention Collaborative, a non-profit organization, is currently applying for a grant to fund a feasibility study that would evaluate a suicide prevention barrier on the Coronado Bridge. Additional bicycle pedestrian concept studies or evaluations should also take the inclusion of a suicide barrier into consideration.

1. Project Description and Objective

The Coronado Bridge was completed on August 3, 1969, during the celebration of the 200th anniversary of the founding of the City of San Diego. The Bridge is recognized as a landmark and symbol for San Diego. According to Caltrans it is notable among the world's greatest bridges for the number of and size of its concrete towers. There are 30 towers with the tallest over the navigational channel reaching the height of 200 feet, and were designed with a curved cap to echo the mission arch shape associated with San Diego's regional mission-style architecture. The Coronado Bridge was the recipient of the 1970 Most Beautiful Bridge Award of Merit from the American Institute of Steel Construction.

The bridge is for vehicular purposes, with the exception of special running, walking, and cycling events, such as the Navy's Annual Bay Bridge Walk and Run. Lew Dominy, founder and architect of domusstudio architecture, had a vision to provide a unique share-used path to the Coronado Bridge. His concept for this new shared–used path was to create a tubular structure that is placed within the mission arch of the concrete towers under the steel girders, and place it on either side of the roadway deck at the main spans over the navigational channel. The desire for this concept is to have it be integral to the existing bridge and not drastically alter the aesthetic appearance of the existing award winning bridge.

The County of San Diego partnered with the San Diego Association of Governments (SANDAG) and domusstudio architecture, via a "Neighborhood Investment Program" grant to commission the HNTB Corporation to prepare a conceptual level review and assessment of the potential construction of a structural tube for bicycle and pedestrian travel along the Coronado Bridge. The objective of the study is to complete a high-level, fatal flaw assessment of bicycle/pedestrian structural tube alternatives, structural assessment and constructability of their attachment to the Coronado Bridge. The study also includes an assessment of various touchdown roadway connection alternatives for the San Diego and Coronado sides of the bridge.

2. Existing Conditions

The Coronado Bridge is part of State Route (SR) 75. SR 75 begins in San Ysidro to the south and travels westward to Imperial Beach, curving northward along the Silver Strand, enters the City of Coronado via the Silver Stand Boulevard and then continues through the City of Coronado and turns eastward and crosses the San Diego Bay and connects with Interstate 5 in the Barrio Logan neighborhood of the City of San Diego.

SR 75 is part of the National Highway System, which designates it as essential to the nation's mobility, economy, and defense system. SR 75 is also signed as a scenic route from Imperial Beach to Coronado and is eligible for the State Scenic Highway System designation. The annual average daily traffic (AADT) on the Coronado Bridge was 66,000 in 2013, which is the highest AADT on the SR 75 roadway. As part of the SR 75 roadway system, the Coronado Bridge is owned and maintained by Caltrans.

The Coronado Bridge is an iconic structure in the San Diego region. It was designed in the late 1960's and opened to traffic in 1970 as a tolled facility. A seismic retrofit was required in the late 1990's and the tolls were discontinued in 2000, after seismic retrofit was complete. However, the toll plaza was not removed and is still in existence on the Coronado (westerly) terminus of the bridge.

The Coronado Bridge provides connectivity across the San Diego Bay for both the cities of San Diego and Coronado, as well as providing primary access to the North Island Naval Air Station and the Naval Amphibious Base on Coronado Island. The east (San Diego) approach to the main crossing is 1,897 feet long, and extends from the start of the project at-grade to Abutment 1 in the west (Coronado). The main crossing of the San Diego Bay; the Coronado Bridge is approximately 1.4 miles or 7,423 feet in length as it spans the San Diego Bay between the southeast edge of the City of Coronado and Pier 30 in the neighborhood of Barrio Logan in the City of San Diego. Pier 30 represents a transition from the main bridge to the east approach, and is also the point at which the bridge superstructure transitions from steel to concrete. The east approach structure extends from Pier 30 to Abutment 2 at the west end of the crossing and is an additional 1,966 feet long. The total length of the crossing is 11,286 feet.

Coronado Bridge Roadway Geometrics

The Coronado Bridge is comprised of 29 spans from the westerly terminus, starting with Abutment 1 and progressing from Pier 2 through Pier 30 to Harbor Drive in San Diego (see Figures 1,2 and 3 on the following pages).

The western terminus of the bridge connects to an at-grade portion of roadway and spans the Bayshore Bikeway, a Caltrans maintenance road and drainage ditch, between Pier 2 and Abutment 1. The eastern bridge structure is above grade and passes over overhead utility lines, shipping pier parking lots, and an existing freight railroad. Beyond Pier 30, the roadway continues on structure and begins to widen and separate to accommodate the interchange ramps connecting with Interstate 5. This portion of the roadway is approximately 1,968 feet or 0.4 miles and passes over Harbor Drive, the existing MTS trolley system, Main Street, Newton Avenue, National Avenue, and an existing Caltrans maintenance facility.

The horizontal alignment of the existing structure consists of two tangents perpendicular to each other connected by a 2,827.43 foot long curve with a 1,800 foot radius that occurs between Piers 4 and 17.

The vertical alignment consists of the roadway climbing at 4.67% both from the Coronado and San Diego touch-down points. The grades are connected by a crest vertical curve of 2,100 feet, which occurs over the three, U.S. Navy / Coast Guard required navigational channels between Piers 18 and 21.

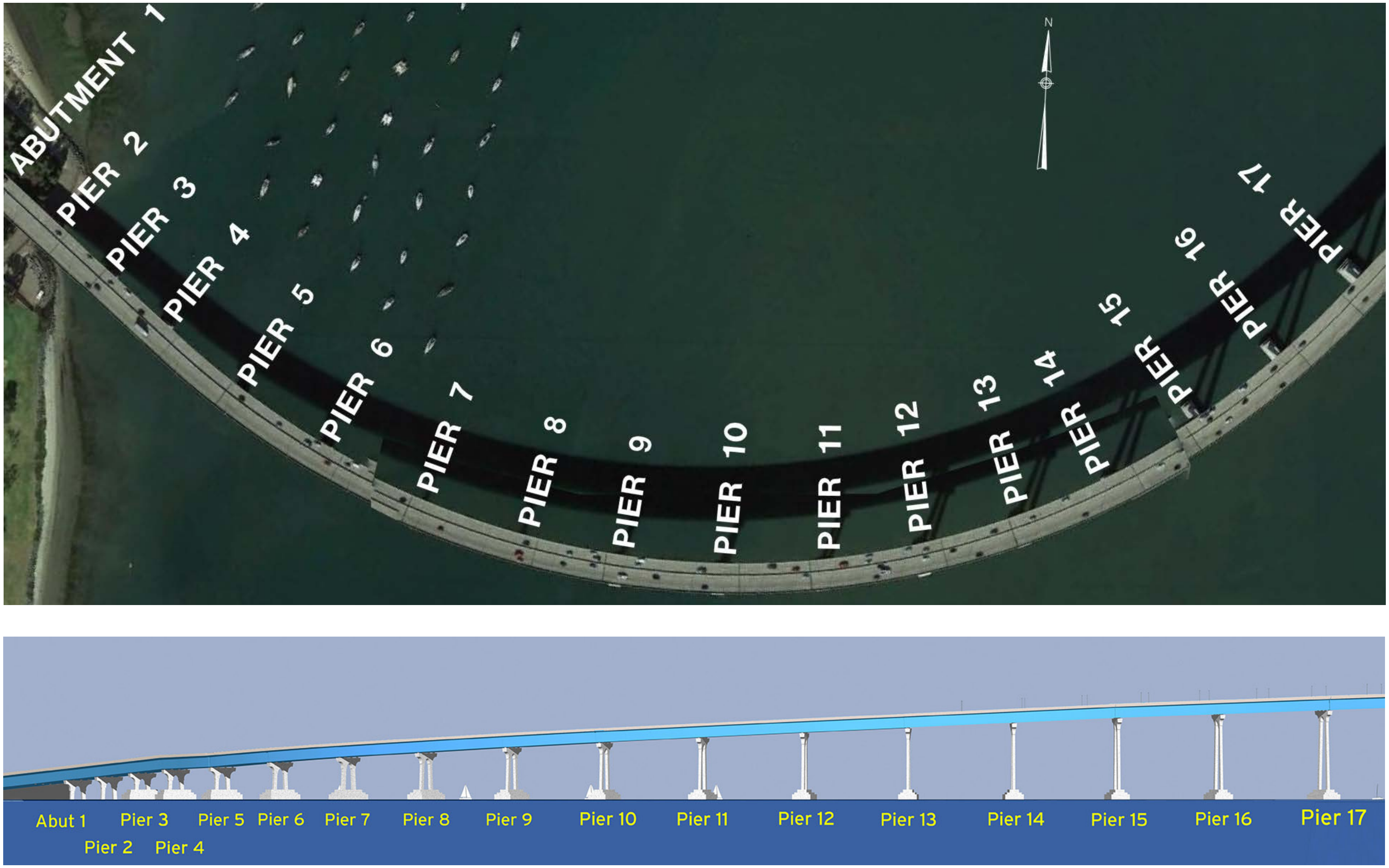

Figure 1 – Coronado Bridge Aerial and Elevation (Abutment 1 through Pier 17) – Western Extent to Mid-Span

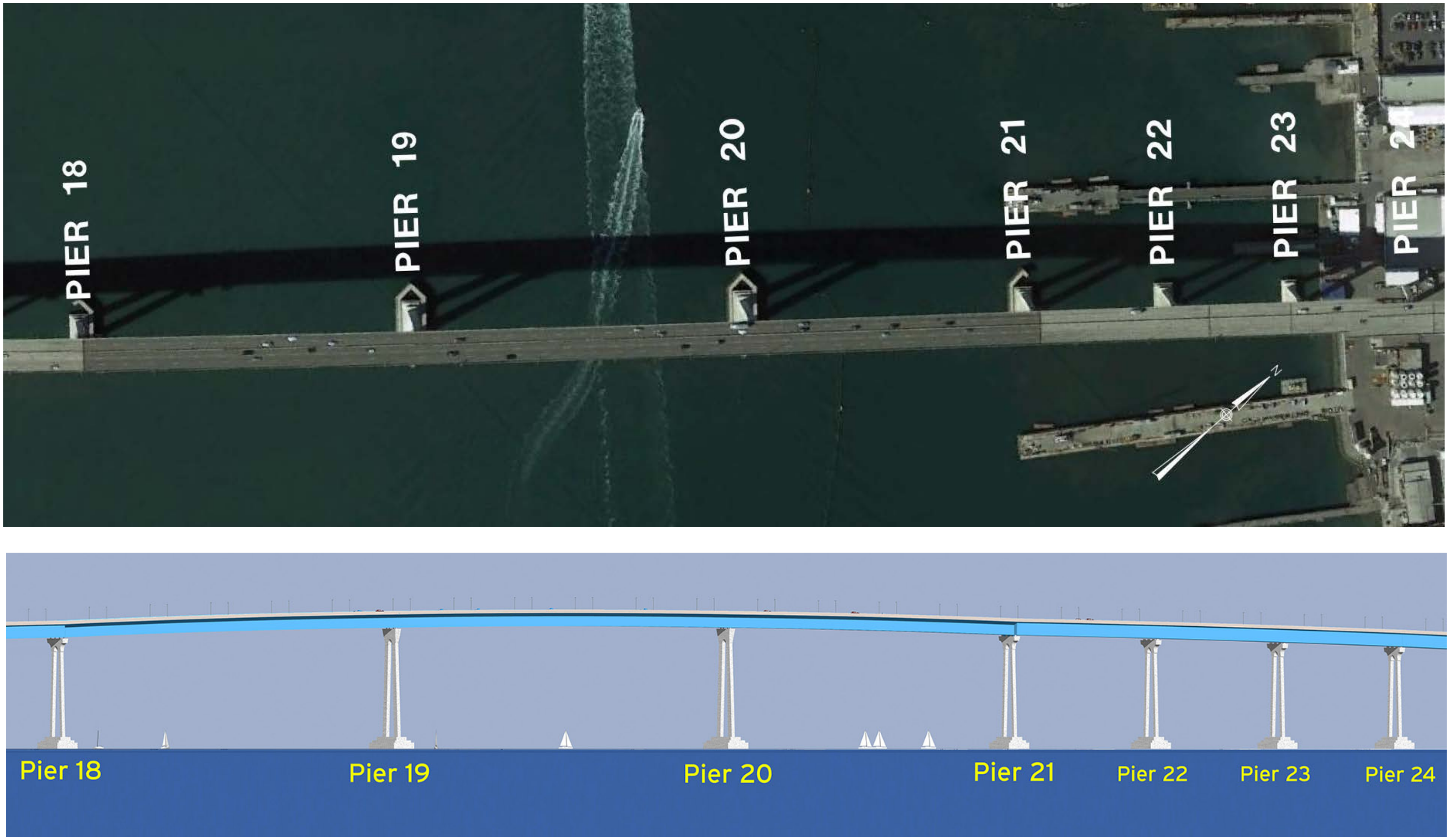

Figure 2 – Coronado Bridge Aerial and Elevation (Pier 18 through Pier 24) – Mid-Span to Eastern Extent

Figure 3 – Coronado Bridge Aerial and Elevation (Pier 25 through 36) – Eastern Extent to I-5 Ramps

Navigation Channel Requirements

The U.S. Navy has multiple facilities for large military vessels within San Diego Bay, many of which are located south of the Coronado Bridge. In order to maintain access to the facilities south of the Coronado Bridge, the U.S. Navy and Coast Guard have navigable requirements for minimum vertical clearance from mean sea level to the underside of the bridge structure/roadway deck (Appendix A – Department of the Navy response). As noted earlier, there are three required navigable channels, which are located between bridge piers 18 and 21. The two westerly navigation channels (located between Piers 18 and 19, and 19 and 20) have a required minimum vertical clearance of 197.12 feet, whereas the third easterly channel between Piers 20 and 21 has a vertical clearance of 177.12 feet. Figure 4 provides a graphic depiction of the required navigation channels between Piers 18 and 21.

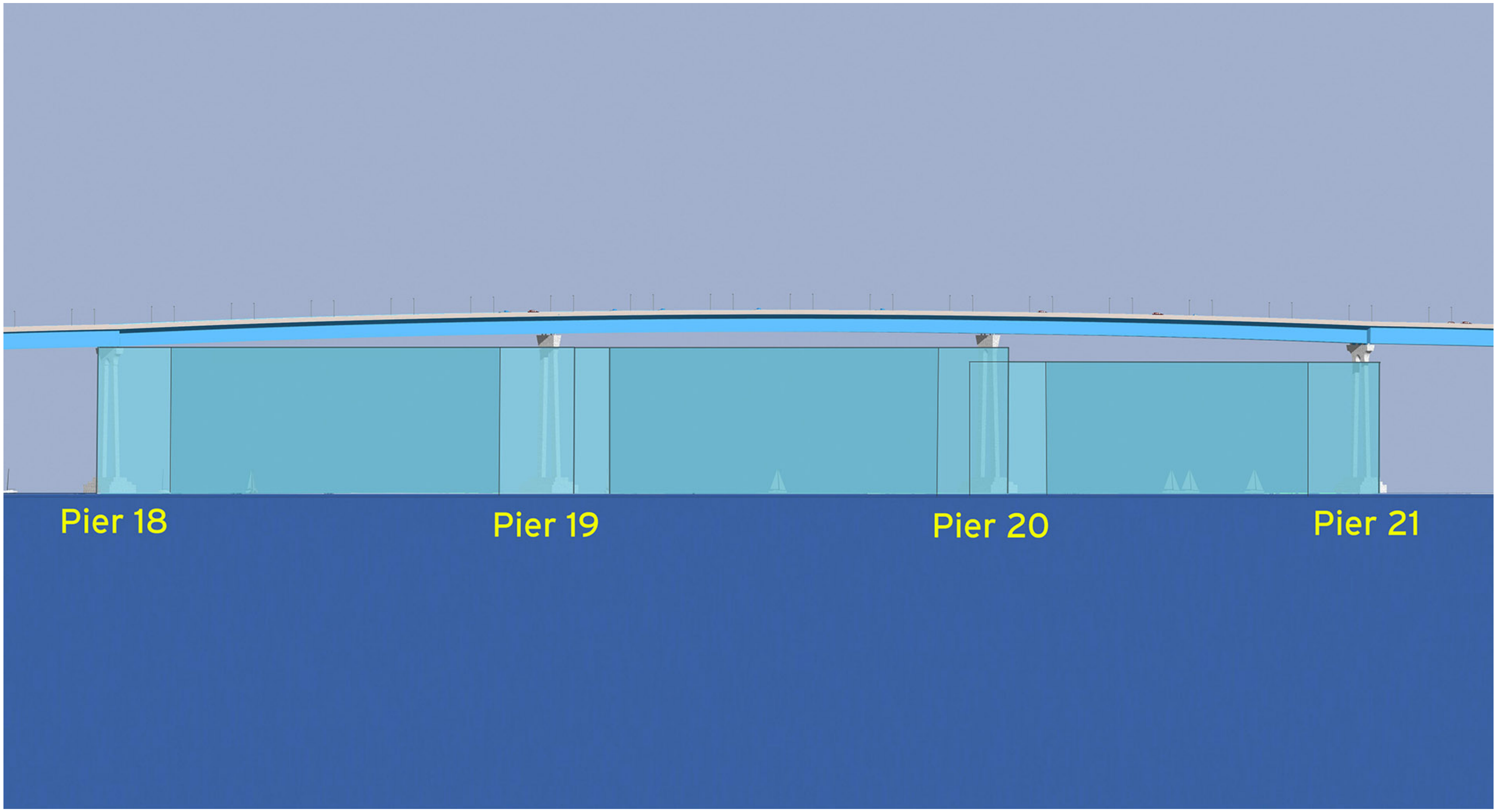

Figure 4 – Navigation Channels between Piers 18 and 21 (looking north)

3. Alignment and Geometric Assessment of a Conceptual Bicycle/Pedestrian Facility

The Team was asked to assess the alignment options and geometric needs of a bicycle/pedestrian facility associated with the Coronado Bridge. Section 3 provides detail on the potential alignment options reviewed and the geometric requirements of the tube structure based on current Caltrans standards and the potential challenges associated with each conceptual alignment. The section first provides an overview of the initial alignment concept as well as other alignment options, identifies the geometric requirements associated with a tube structure, and provides a high level description of each alignment's interaction with the existing bridge.

Initial Alignment Concept – Pier Archway Location

An initial concept was developed to take advantage of the center archways of the bridge piers, in order to preserve the architectural and aesthetic principals of this iconic bridge. The initial bicycle/pedestrian concept is for a tube-type structure to be located primarily within the center archway of the Coronado Bridge piers. In order to provide observation decks on the north and south side of the bridge, the facility would swing out from under the center arch between Pier 18 and 19, transitioning the alignment to the southern side of the bridge, and then transition back to the northern side of the bridge between Pier 19 and 20, and then transition back under bridge structure to the archway of Pier 21. Figures 5 through Figure 7 depict the initial concept alignment (shown in green) within an aerial and elevation context. The transition of the alignment from underneath the piers to the south and north sides of the bridge is shown in Figure 6, with a close view of the side to side transitions at the navigation channels shown in Figure 6A. The conceptualized viewing platform proposed at Pier 20 is shown in Figure 8.

The initial bicycle/pedestrian facility structure was conceptualized with an approximate outer diameter of 14 feet, which was anticipated to allow for construction within the center archway of the bridge piers. Figure 9 provides a cross-section view of the initial concept structure and it's placement within the center archway of a pier.

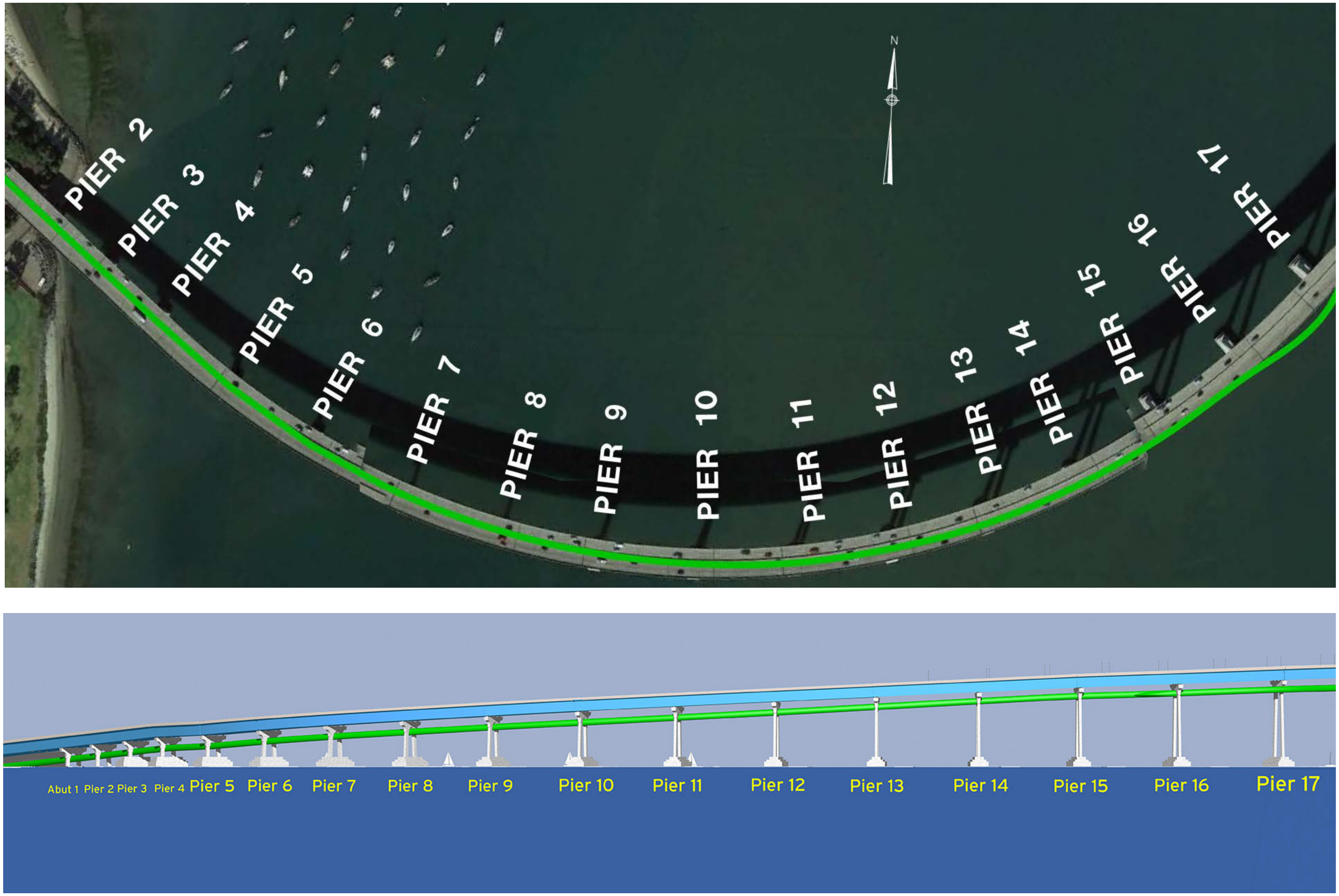

Figure 5 – Proposed Concept (shown in green) Abutment 1 through Pier 17 – Western Extent to Mid-Span

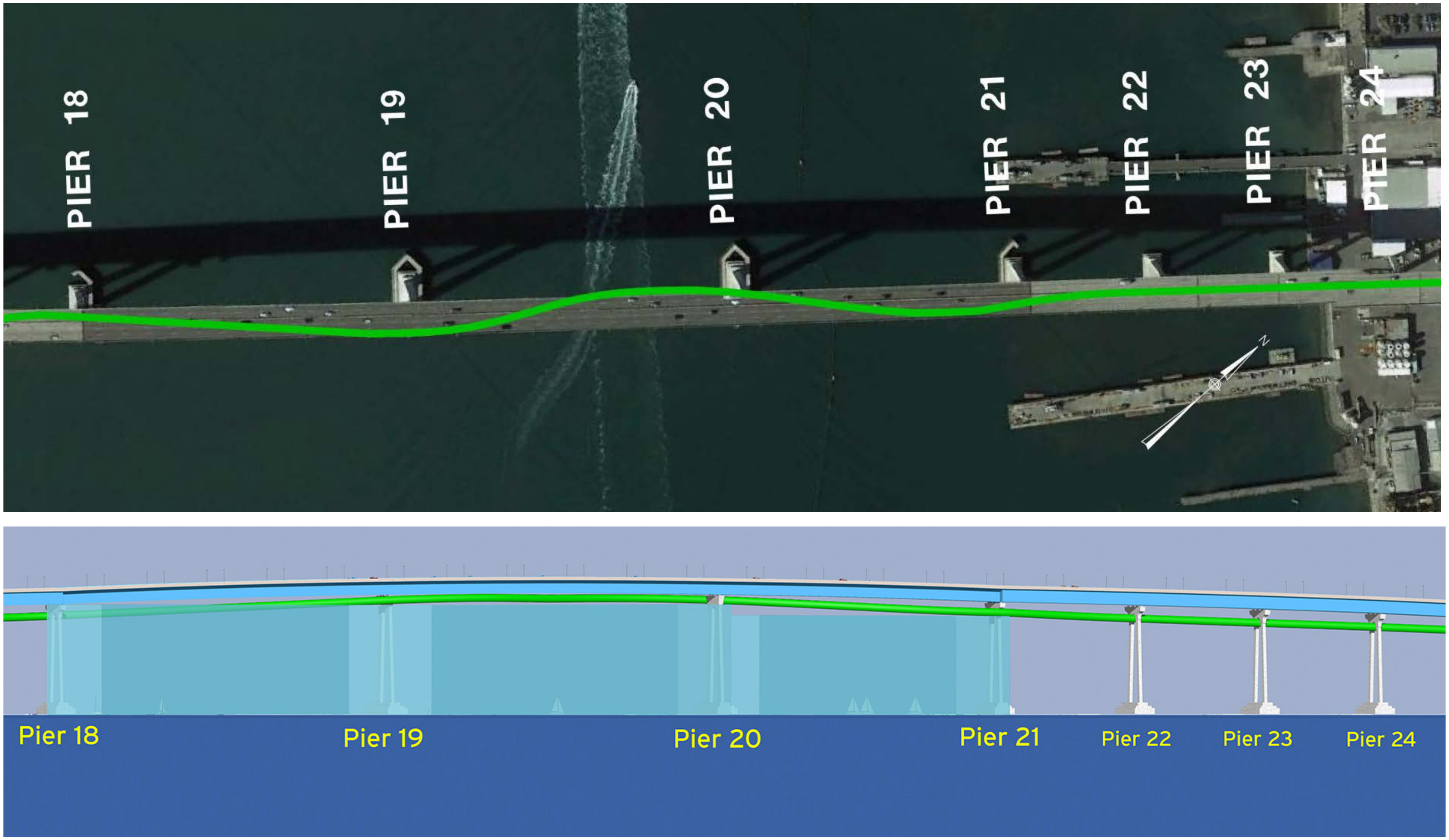

Figure 6 – Initial Concept (shown in green) Pier 18 through Pier 24 – Mid-Span to Eastern Extent

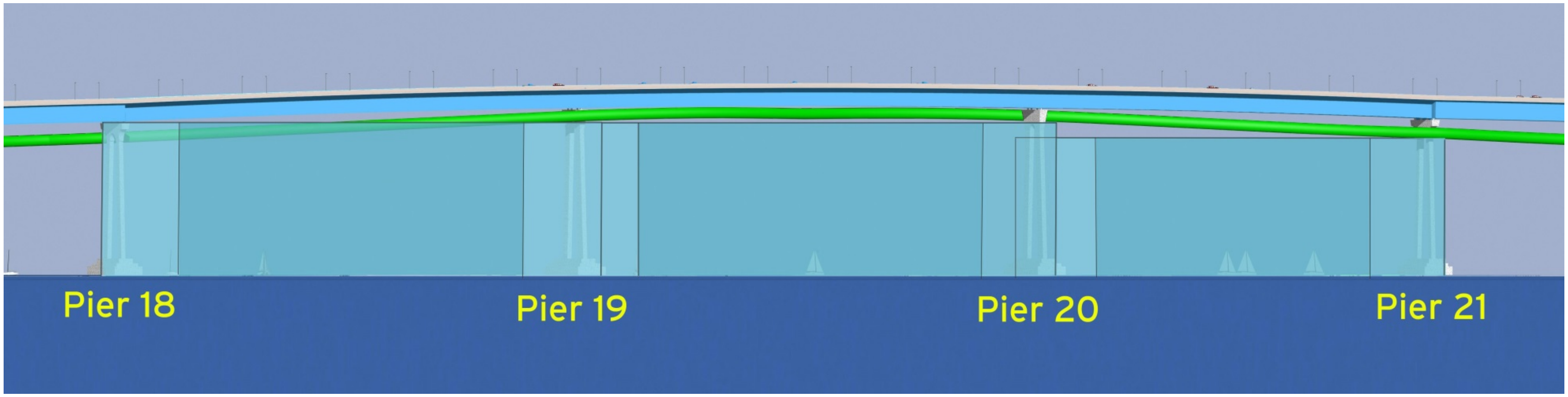

Figure 6A – Close View of Side to Side Transitions at the Navigation Channels (Pier 18 - Pier 21)

Figure 7 – Coronado Bridge Aerial and Elevation (Pier 25 through 36) – Eastern Extent to I-5 Ramps

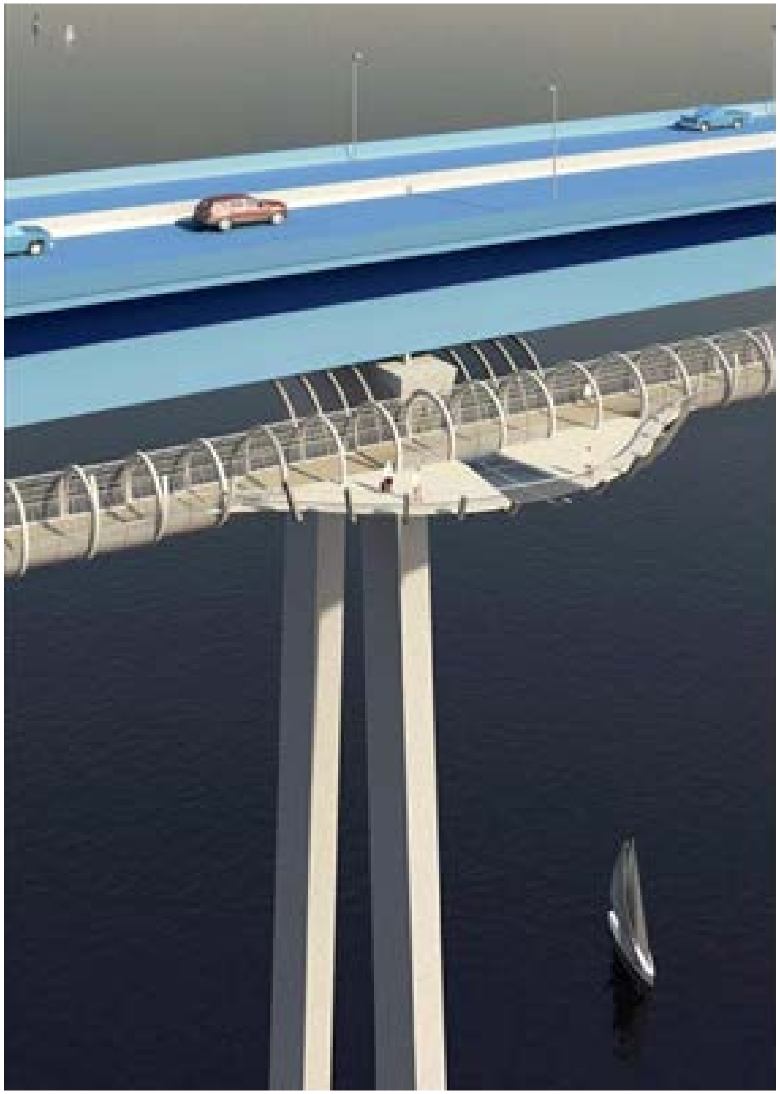

Figure 8 – Conceptualized Viewing Platform at Pier 20 (courtesy of domusstudio architecture)

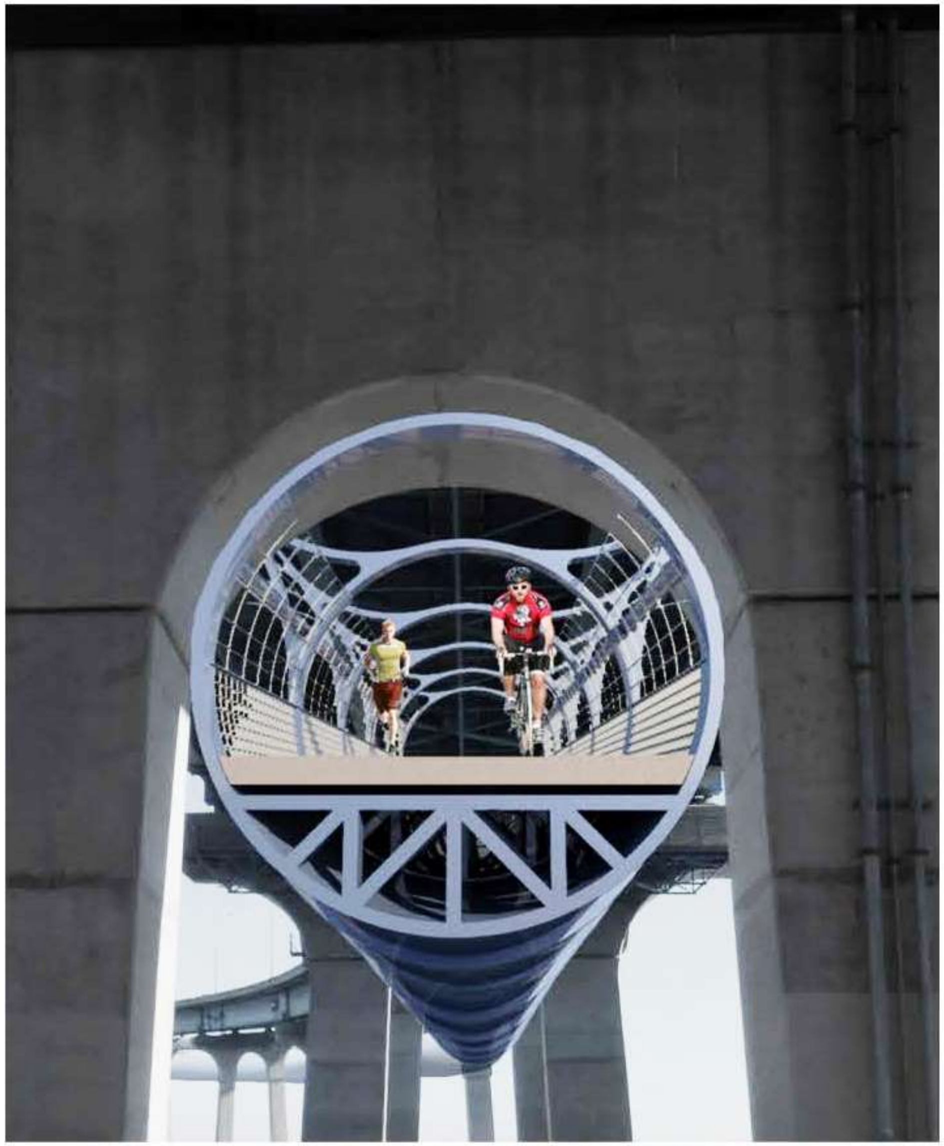

Figure 9 –Initial Conceptual Bicycle/Pedestrian Facility Structure Cross-Section (courtesy of domusstudio architecture)

Alignment Alternative Concept – Pier Cap Location

The Team also identified an alignment option that would locate the potential bicycle/pedestrian facility at the approximate level of the pier caps. This alignment could be placed either on the north or south side of the existing bridge structure.

Alignment Alternative Concept – Bridge Deck Location

The third alignment identified by The Team placed the bicycle/pedestrian structure alongside the roadway bridge deck. Like the pier cap location, this alignment could be placed on either the north or the south side of the existing bridge structure pending feasible connection points.

Figure 10 on the following page provides a graphic depiction of the three alignments developed as part of this conceptual level assessment of a bicycle/pedestrian facility attached to the Coronado Bay Bridge.

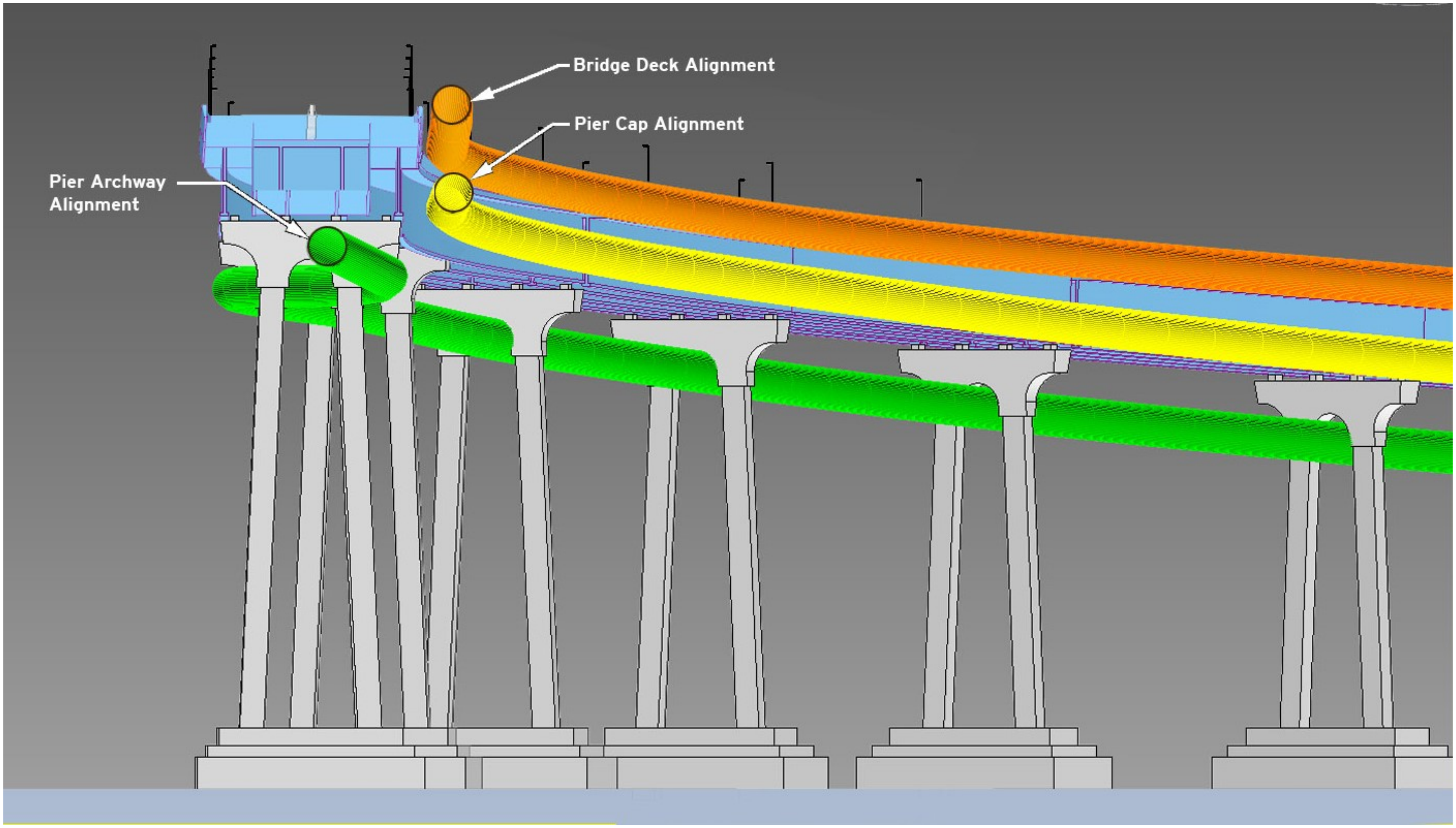

Figure 10 – Alignment Options (Pier Archway, Pier Cap and Bridge Deck) Relative to Existing Bridge Structure

Initial Geometric Review

The Team reviewed the current Caltrans geometric specifications and requirements associated with bicycle/pedestrian facilities relative to placement on the Coronado Bridge structure and developed a high-level assessment of alignment alternatives presented above (Pier Archway, Pier Cap and Bridge Deck – hereafter referred to as Bottom, Middle and Top).

Bicycle/Pedestrian Facility Specifications

The Team reviewed the Caltrans Highway Design Manual (HDM) and the Caltrans Design Information Bulletin (DIB) to determine the required specifications for a bicycle path on a structure. The specifications will not only define the size of the bicycle/pedestrian facility, but will also determine the ability of the bicycle/pedestrian facility to fit or be constructed within the center archway of the Coronado Bridge piers or alongside the superstructure – particularly the pier caps and the bridge deck.

The Caltrans HDM and DIB included the following specifications for bicycle/pedestrian facilities:

<u>Width</u>

- The clear width of a bicycle path on structures between railings shall be not less than 10 feet. (Caltrans HDM 1003.1 (2))

<u>Vertical clearance</u>

- 80 inches minimum (Caltrans Design Information Bulletin (DIB) 82-05-Pedestrian Accessibility Guidelines for Highway Projects).
- 8 feet over bike path and 7 feet over shoulders (HDM 1003.1 (2)).

<u>Grade</u>

- 5% Maximum (DIB 82-05 4.3.4 (3)).

<u>Landings</u>

- Minimum 5 foot landing (2% slope or flatter) every 400 feet (DIB 82-05 4.3.4 (1)) when grades are greater than 2%.

The Team used the above noted Caltrans specifications to develop standard cross-sections and assess the feasibility of the proposed alignments. The results of the initial review and assessment for geometric needs are provided in the following sections.

Standard Cross-Sections

The Team developed two cross-sections utilizing the current Caltrans HDM standards and specifications for bicycle/pedestrian facilities – a Minimum Criteria and Expanded Criteria concept.

Minimum Criteria Concept

The Minimum Criteria concept cross-section represents a structure that would meet- the minimum requirements and provide eight feet of vertical clearance over the facility path and a pathway width of 10 feet. However, given the semi-enclosed nature of the tube concept, these dimensions may feel somewhat limiting and thus may not provide users with a comfortable or enjoyable user experience.

The Minimum Criteria concept appears to fit within the center arch of the piers, when considering the inner diameter only. Based on Caltrans standards, the minimum interior diameter of the proposed facility would be 13.7 feet. While the archway would accommodate the minimum interior diameter, the interior diameter does not include or account for the structural components and associated width necessary to support the proposed structure. As a result, the ability of the Minimum Criteria concept to fit within the center arch of the piers will depend on the required configuration/size of the structural components, which will determined the ultimate outer diameter of the tube structure.

Expanded Criteria Concept

The Team also developed an Expanded Criteria concept that may better address anticipated user experience concerns associated with the Minimum Criteria concept. The Expanded Criteria concept provides for a facility that exceeds the minimum Caltrans requirements, providing a structure that is wider and taller by using a larger inner radius. The larger inner radius of the Expanded Criteria concept provides an additional two feet in height and an additional four feet for the pathway width. However, as is shown in Figure 11, the Expanded Criteria concept is not anticipated to fit within the center arch of the existing bridge piers, but could be located at the pier cap or bridge deck level.

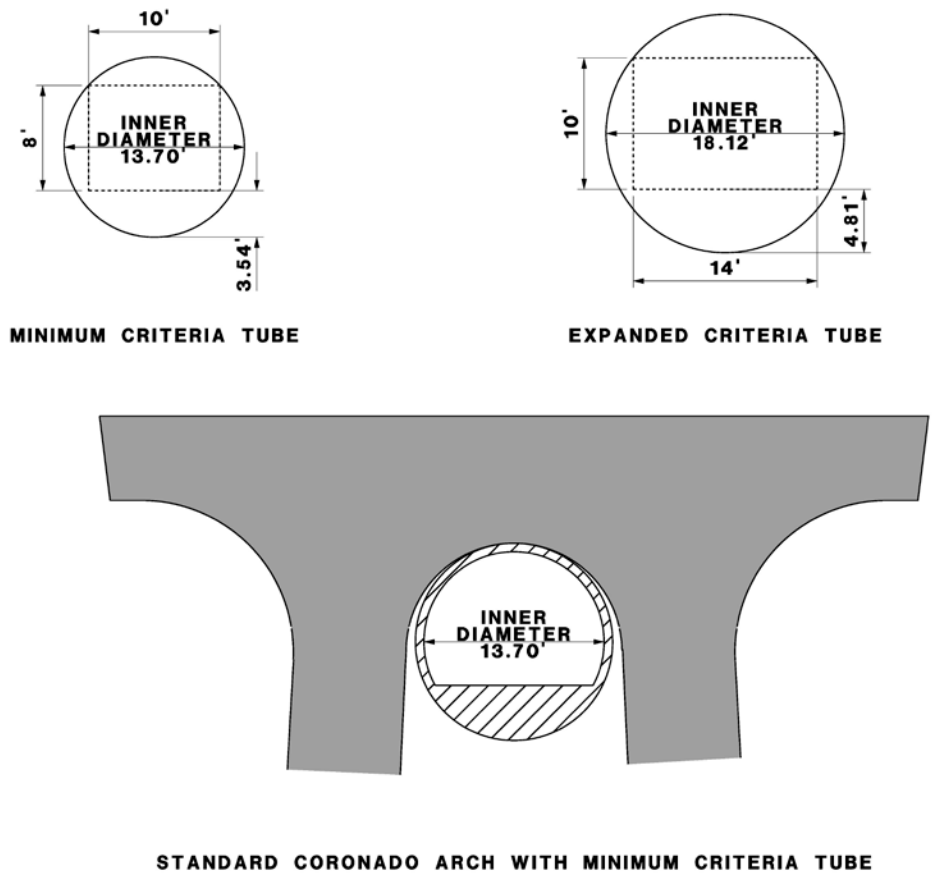

Figure 11 – Bicycle/Pedestrian Facility Standard Cross Sections for a Tube Concept

Conceptual Alignments Assessment

Pier Archway Alignment

As previously discussed, the initial conceptual alignment was intended to be designed and constructed to fit within the center archway of the bridge piers to preserve the architectural and aesthetics of this iconic bridge. However, the following challenges were found when both the roadway geometrics and the standards and specifications for a bicycle path on a structure were further detailed and defined:

- Encroachment into the navigation channels
- Minimum standards for a bicycle/pedestrian structure exceed center arch geometrics

The encroachment into the navigation channel is due primarily to two design components – the American with Disabilities Act (ADA) standard requirement to maintain a grade of five percent or less (without provision of a landing) and the required Caltrans geometry associated with bicycle/pedestrian facilities. The five percent grade becomes an issue at Pier 18. In order for the proposed facility to travel through the arch at Pier 18 and also avoid the navigational channel envelope between Piers 18 and 19 would require a pathway grade requirement greater than 5 percent, and is not expected to be a feasible design option considering the need to adhere to ADA standards. As a result, the Pier Archway concept would encroach into the navigational channel; the encroachment into the navigation channel between Piers 18 and 19 is approximately 270 feet in length and approximately 30 feet below the required 197.12 feet of clearance from mean sea level. Figure 12 shows a graphic depiction of the proposed facility and the encroachment at Pier 18 and Figure 13 provides a side view of the conflict point at the navigation channel between Pier 18 and 19.

Pier Cap Alignment

This alignment would provide the ability to clear the navigational channel at Pier 18 and also maintain the 5 percent or less ADA grade requirements. However, bringing the structure back into the pier archways is challenging as the change in grades ultimately pushes out the transition of the facility to the under arch configuration a significant distance, particularly on the western side. While the facility could transition back under the structure arch at Pier 22 on the eastern side, it does not allow for a transition on the western side until Pier 3.

As a result, the proposed structure would not be under the arches for a majority of the alignment, but would instead travel alongside the bridge structure roughly aligning with the pier caps or bridge girders. Considering the distance required for the proposed facility to come back under the arch it may be beneficial to maintain the proposed bicycle/pedestrian facility at a constant depth relative to the bridge, which may provide constructability benefits and reduce overall costs.

A challenge associated with this alignment is the anticipated interference with the travel system that is mounted to the pier caps and girders of the center spans. The traveler system is used for bridge painting and maintenance activities and it is expected that aligning a bicycle/pedestrian structure at this location would impact the existing traveler system and ultimately require the development of a new system for maintenance activities.

Bridge Deck Alignment

This alternative alignment could avoid encroachment into the navigation channels, maintains a five percent or less, grade and may also provide easier transition points to existing bicycle and roadway facilities on both the Coronado and San Diego sides of the bridge. Locating the alignment at the bridge deck level also removes the conflict with the current traveler system. However, The Team also identified two challenges associated with this alternative – placing the tube at the bridge deck level would block the views of motorists traveling across the bridge and also has a great potential to impact the overall aesthetics of the bridge, by introducing a secondary structure that may not appear to blend-in or be hidden by the existing structure in the same manner as the Pier Archway and Pier Cap alternatives.

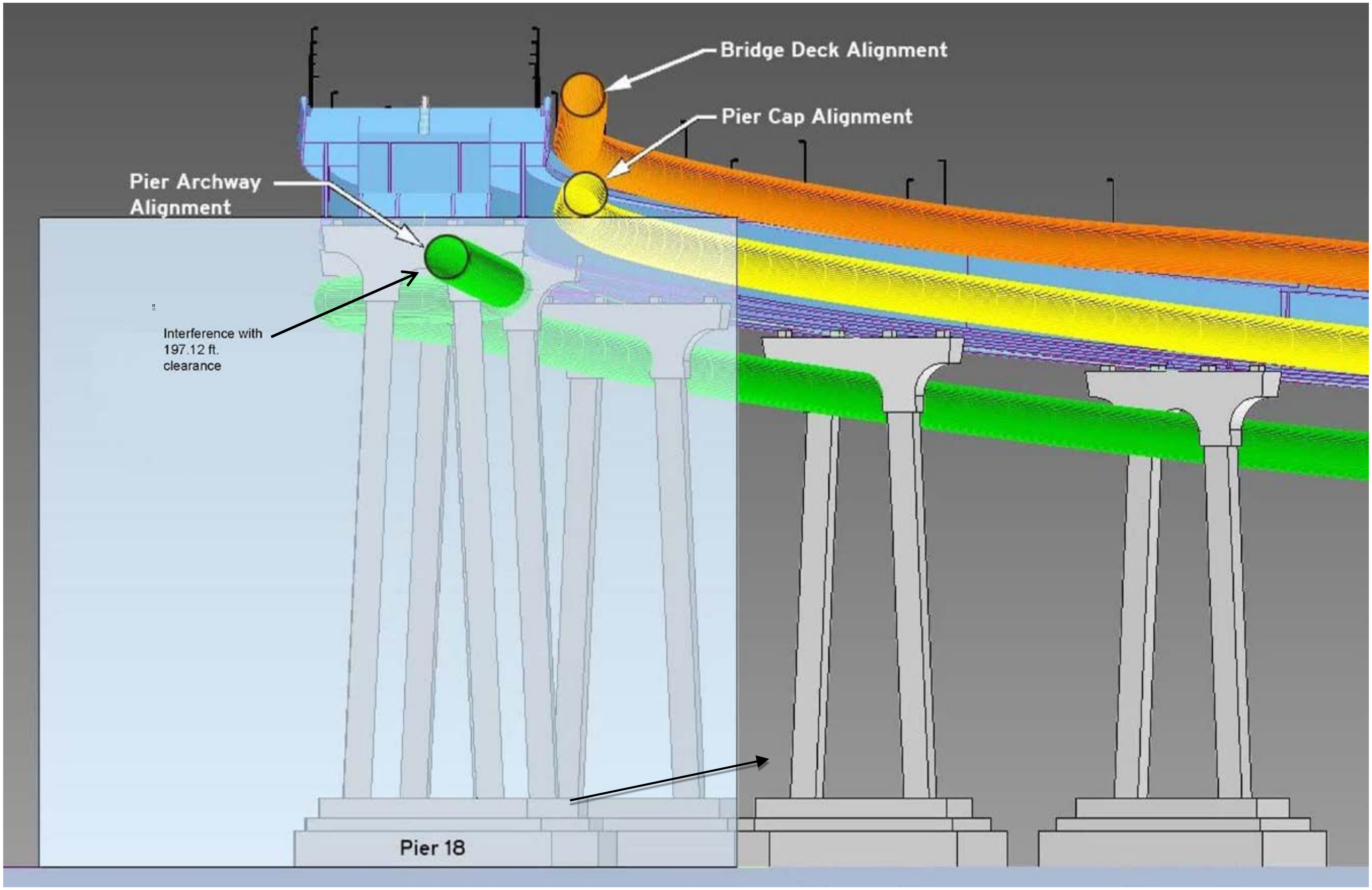

Figure 12 – Position of Pier Archway, Pier Cap and Bridge Deck Alignments Relative to Navigational Channel at Pier 18

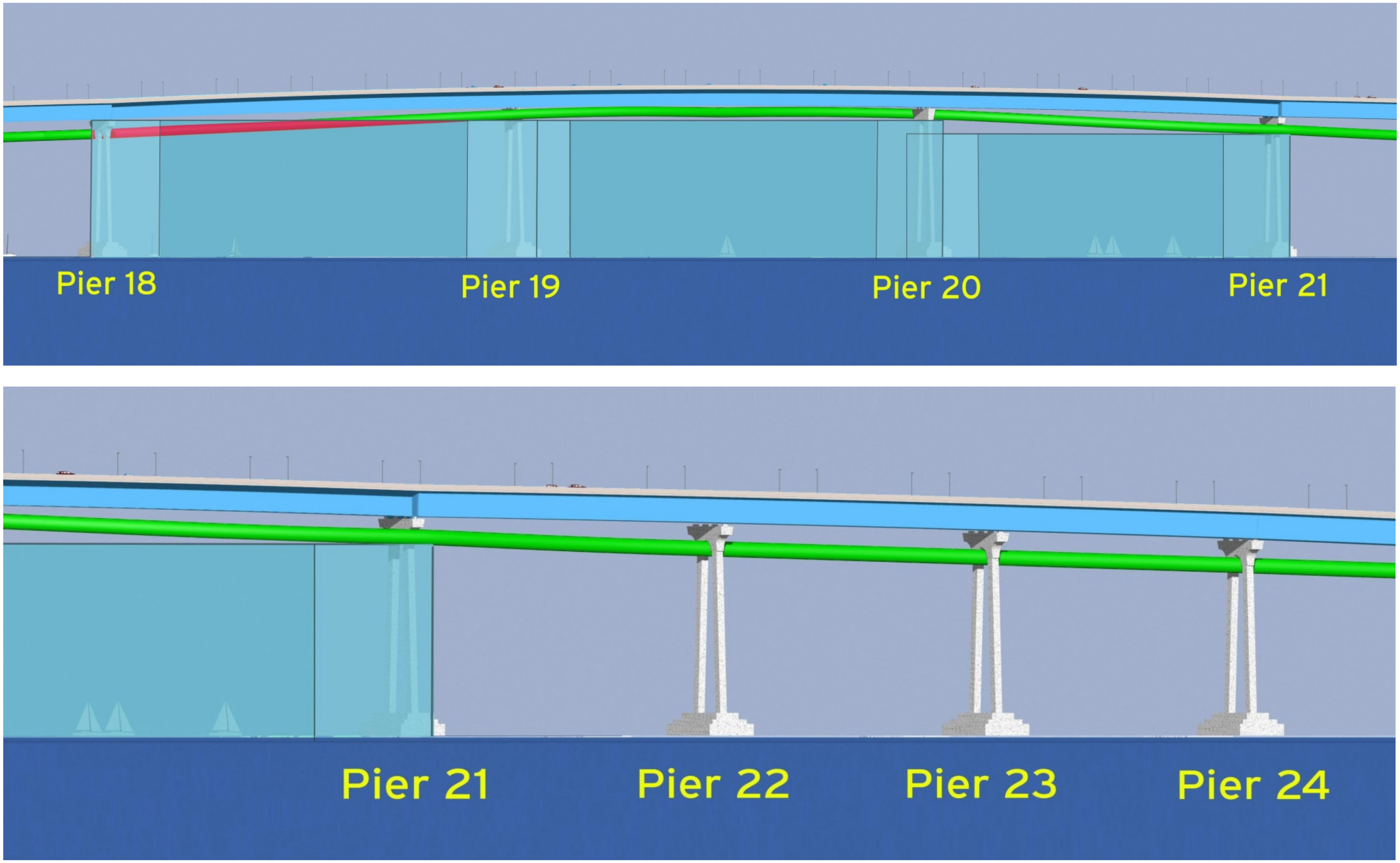

Figure 13 – Side to Side Transitions at the Navigation Channels and Conflict Point at Pier 18 (shown in red)

4. Roadway Connection Points

Section 4 reviews potential connection points to the existing bicycle and roadway network on either end of the bridge in the cities of Coronado and San Diego. As part of the initial site visit The Team reviewed the bridge location with the overall neighborhood, existing bicycle facilities, and the roadway facilities within a roughly two to three block area. The following section provides additional detail on the connection point options identified and an assessment of benefits or challenges associated with each connection option. The initial concepts and options were developed to match with the original center arch location of the proposed facility, but connection points for alignments that are on the north and south sides of the bridge were developed as well.

Western Connection Points

A total of three connection options were identified and conceptualized for the Coronado connection. As noted above, the first two connection points were originally developed to transition from the center arch alignment and were modified to reflect an alignment located on the north side of the bridge, whereas the third connection option presented was developed as part of the higher, bridge deck alignment option.

Caltrans Maintenance Yard Connection

This connection point transitions the proposed bicycle/pedestrian facility from the bridge environment to the Silver Strand Bikeway via right angle turns with stop control immediately after Pier 2 and utilizes the Caltrans maintenance facility right-of-way, on the southern side of the Coronado Bridge, to directly connect with the Silver Strand Bikeway. Figure 12 presents the aerial view of the maintenance yard connection and Figure 13 provides a view of the maintenance yard from under the bridge deck from Abutment 1.

The following benefits and challenges were identified during the development of this option.

Benefits:

- Ties directly into the Silver Strand Bikeway – an existing shared use facility.
- Transition occurs relative to bridge facility (no additional water columns are required).

Challenges:

- Would create a right turn at the end of an extended portion of bikeway that would range from 4.67% - 5.00%

- Maintaining a five percent grade would mean that the proposed facility would be at a variable depth relative to each pier as the facility approaches Coronado, and would therefore reduce overhead clearances for boats in the last few bridge spans.

Figure 12 – Caltrans Maintenance Yard Connection Aerial View

Figure 13 – Caltrans Maintenance Yard Connection Site Photo

Northerly Connection to the Silver Strand Bikeway

The northerly connection to the Silver Strand Bikeway maintains an alignment on the northern side of the Coronado Bridge, crossing out into the San Diego Bay and connects to the Silver Strand Bikeway as it approaches the Coronado Tidelands Park. Figure 14 presents the aerial view of the northerly connection to the Silver Strand Bikeway and Figure 15 view of the connection point looking south to the bridge and north towards the park and Caltrans maintenance roadway. The following benefits and challenges were identified during the development of this option.

Benefits:

- Ties directly into the Silver Strand Bikeway – an existing shared use facility.
- Provides a better transition from the bridge facility to the Silver Strand Bikeway, as it does not require right-hand turns.

Challenges:

- The connection point will require yield signs for all movements and potentially stop signs for some connections.
- Maintaining a five percent grade would mean that the proposed facility would be at a variable depth relative to each pier as the facility approaches Coronado, and would therefore reduce overhead clearances for boats in the last few bridge spans.
- Would require at least one new column in the San Diego Bay to support the proposed structure as it approaches the connection point to the Bay Shore Bikeway.

Figure 14 – Northerly Connection to the Silver Strand Bikeway Aerial View

Figure 15 – Silver Strand Bikeway near Connection Point (looking south and north) Site Photo

Extended At-Grade Connection

The extended at-grade connection maintains the an alignment on the northern side of the Coronado Bridge, but instead of traversing away from the bridge to the north, the alignment would remain parallel with the roadway as it approaches the existing toll-booths. This option utilizes the available right-of-way that is associated with the roadway and toll-booth area. Connection to the Silver Strand Bikeway could be accomplished in two ways. The first option would be to utilize the existing Caltrans maintenance roadway that is located immediately adjacent and to the north of the existing roadway, and the second option would be to add bicycle lane striping to Mullinex Drive (Coronado Tidelands Park access road) to the Bayshore Bikeway access points that are connected to the cul de sac.

Figure 16 presents the aerial view of the at-grade connection to the Caltrans maintenance roadway. The following benefits and challenges were identified during the development of this option.

Benefits:

- Does not require right angle turns.
- Would tie into grade utilizing existing roadway right-of-way.
- Would not impact any vertical clearances in the bridge spans, as the proposed facility would remain at the same grade as the roadway bridge deck.
- Multiple connection options to the Bayshore Bikeway.

Challenges:

- The Caltrans maintenance roadway appears to also be a drainage/run-off channel.
- Does not create a direct connection to the Bayshore Bikeway.

Figure 16 – Extended At-Grade Connection Aerial View

San Diego/Eastern Connection Points

A total of three connection options were identified and conceptualized for the Eastern (Barrio Logan) connection. All three of the connection points were initially developed to transition from the center arch location, but can be modified as shown to reflect an alignment that is on the northern side of the bridge structure.

<u>Harbor Drive North</u>

The Harbor Drive North connection option would transition the proposed structure from the northern side of the bridge to the center median of Harbor Drive, ultimately coming to grade at the intersection with Beardsley Street. Once at the intersection, cyclists and pedestrians would transition to the northbound and southbound Harbor Drive bicycle and sidewalk facilities using crosswalks or a potential "All Walk" signal.

Figure 17 presents the aerial view of the Harbor Drive North connection and Figure 18 is a view to the bridge from near the approximate connection point to Harbor Drive at Beardsley Street. The following benefits and challenges were identified during the development of this option.

Benefits:

- Direct connection to the existing and proposed Bayshore Bikeway (existing northbound, proposed southbound).

Challenges:

- In order to maintain a five percent grade during the transition and meet roadway grade at Beardsley Street, the proposed facility would need to begin descending immediately after the navigation channels and would be at a variable depth relative to the existing bridge.
- May need to provide additional clearance over Cesar Chavez Parkway due to shipyard trucking clearance needs.
- Intersection improvements would be needed at the Beardsley Street and Harbor Drive intersection to accommodate the addition of bicycle traffic in the median and their transition to the existing bicycle network.
- Port and shipyard traffic into and out of Cesar Chavez Parkway may be impacted by signal changes at Beardsley Street, due to the short block length.

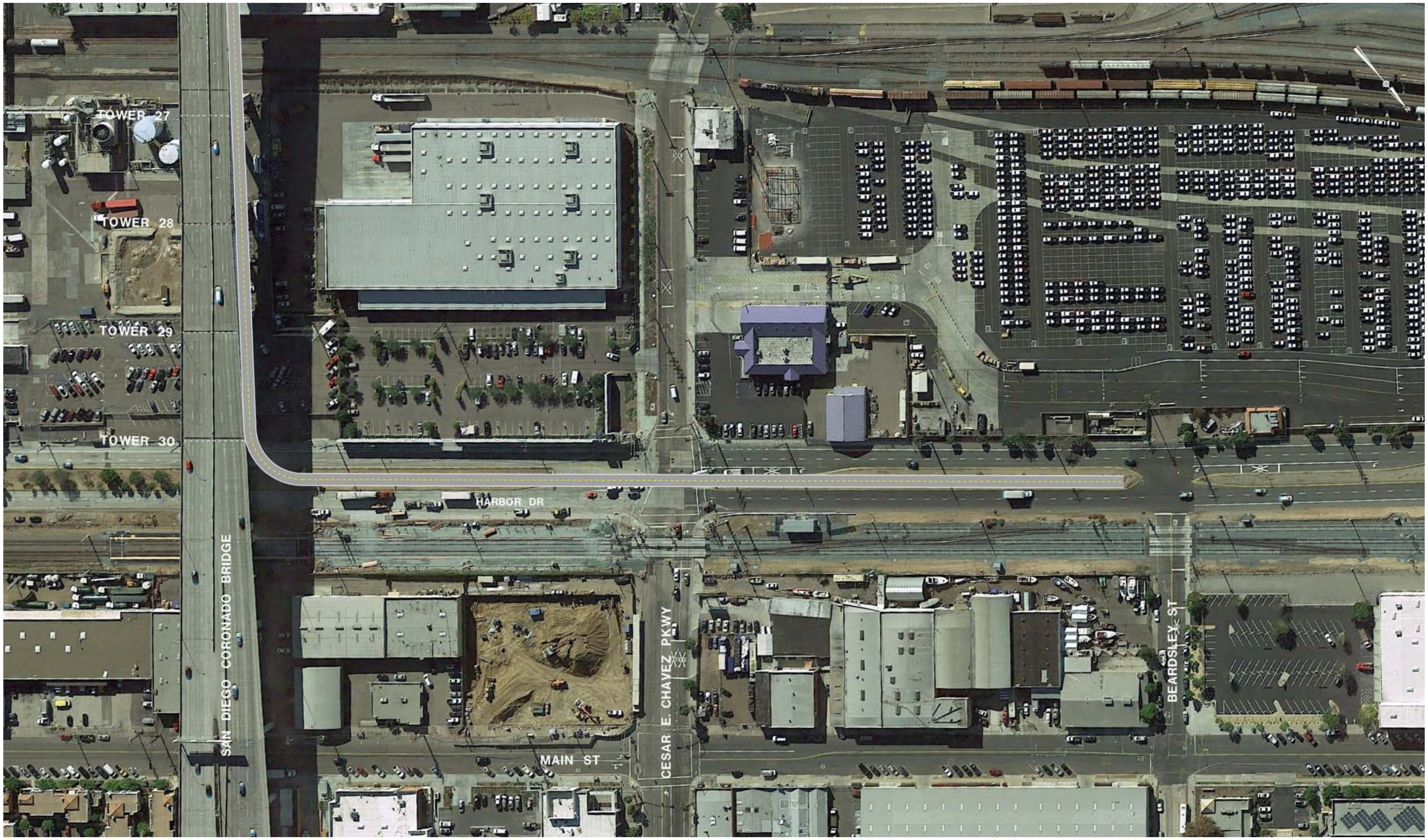

Figure 17 – Harbor Drive North Connection Aerial View

Figure 18 – Harbor Drive North Connection Point near Beardsley Street Site Photo

Harbor Drive South

The Harbor Drive South connection option, shown in Figure 19, would transition the proposed structure from the northern side of the bridge to the center median of Harbor Drive, passing under the Coronado Bridge and ultimately coming to grade at the intersection with Beardsley Street. Once at the intersection, cyclists and pedestrians would transition to the northbound and southbound Harbor Drive bicycle and sidewalk facilities using crosswalks or a potential "All Walk" signal.

The following benefits and challenges were identified during the development of this option.

Benefits:

- Direct connection to the existing and proposed Bayshore Bikeway (existing northbound, proposed southbound).
- Does not cross over a secondary street before transitioning to grade at Sampson Street (due to longer block length to the south).

Challenges:

- In order to maintain a five percent grade during the transition and meet roadway grade at Sampson Street, the proposed facility would need to begin descending immediately after the navigation channels and would be at a variable depth relative to the existing bridge.
- Intersection improvements would be needed at the Sampson Street and Harbor Drive intersection to accommodate the addition of bicycle traffic in the median and their transition to the existing bicycle network.

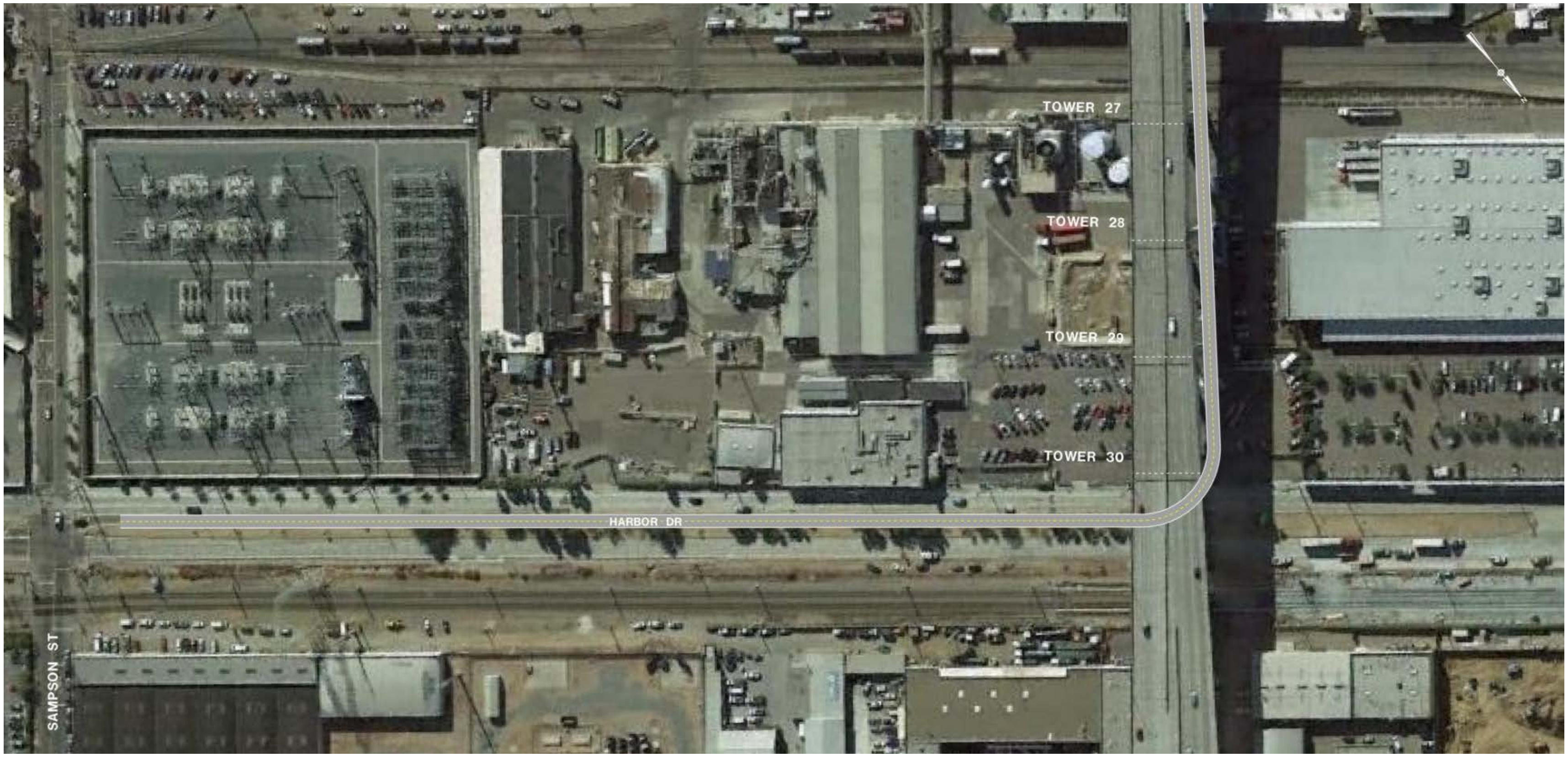

Figure 19 – Harbor Drive South Connection

National Avenue

The National Avenue connection option would continue past Harbor Drive and continue east towards National Avenue, transitioning away from the bridge structure near Pier 36 in order to move the proposed facility into an area immediately adjacent and north of Cesar Chavez Park. This area consists of an existing paved area that does not appear to be part of Cesar Chavez Park and what appears to be a passively landscaped area that may be within Cesar Chavez Park. After the proposed facility transitions away from the bridge, the structure is anticipated to be supported by a single column structure that would allow for 16.6 foot vertical clearance of Newton Avenue, transitioning to grade just short of National Avenue. Figure 20 presents the aerial view of the National Avenue connection and Figure 21 provides a view of the potential connection area looking west toward Main Street and east towards National Avenue.

Connection to the existing and proposed Bayshore Bikeway facility on Harbor Drive would be via pavement markings within the existing roadways system. Potential pavement markings for cyclists could either be a sharrow, denoting that the street is suggested and expected to be used by cyclists, or could be a more formal bicycle lane within the roadway right-of-way. The potential routes would be north and south on National, with cyclists wishing to travel northbound on the Bayshore Bikeway using Cesar Chavez Parkway to access Harbor Drive, or for cyclists wishing to travel southbound on the Bayshore Bikeway, traveling southbound on National Avenue to Sampson Street to access the Harbor Drive facilities.

Benefits:

- Provides cyclists and pedestrians with a more bicycle and pedestrian friendly location to make their transition to the roadway network.
- Connection point does not require right angle movements, which provides easier user navigation and transition from the proposed facility to the city streets.

Challenges:

- Is not a direct connection to the existing and proposed Bayshore Bikeway; use of city streets for access is required (approximately four blocks north or south).
- Requires use of paved right-of-way to the north of Cesar Chavez Park (east of Newton Street).
- Requires use of the landscaped area adjacent/within Cesar Chavez Park
- Potential Section 4f impacts.

Figure 20 – National Avenue Connection

Figure 21 – National Avenue Connection Site Photo (looking west and east)

5. Structural Review and Assessment

The following section provides information on the seismic retrofit completed in the late 1990's, a high-level assessment of the structural feasibility of attaching/constructing the proposed bicycle/pedestrian facility onto the Coronado Bridge.

Existing Bridge

The bridge was designed in the mid 1960's and opened to traffic in August 1969. It is five lanes wide, with no shoulders. A seismic assessment and retrofit of the bridge was completed in the late 1990's. At that time, a number of component items were identified by analysis as deficient for the current seismic criteria, which were subsequently addressed during the retrofit. The components of the seismic retrofit were as follows:

- Foundations
- Substructures – including pile caps, piers and pier caps
- Superstructures – including seismic isolation bearings, bearing restrainers, joint restrainers, and framing

Foundations

The original marine foundations are large diameter (54-inch) precast, prestressed, spun piles that are driven into the bay mud and are backfilled with tremie concrete. As part of the seismic modeling and analysis for the retrofit, the designers modeled the piles and pile caps for seismic capacity and performance.

This analysis included several inflicted-damage scenarios to vertical and hoop steel (to capture the potential impact of the observed distress noted above), and demonstrated that the deep foundations were safe and sufficient under the Caltrans Seismic Design Criteria (SDC).

Substructures

The substructure retrofit typically consists of concrete encasement that is doweled into the existing substructures. In some cases internal posttensioning is included to provide additional strength and ductility.

Superstructures

The plate girder superstructures from the Coronado abutment to the main span box girders (Piers 1 through 18) were retrofit using isolation bearings to reduce seismic demand on the foundations. In addition, joint restrainers and cross-frames were added and strengthened. These measures were also provided at the high level main span structure and the steel girders up to Pier 33 on the San Diego approach. A maintenance traveler was added to all of the above spans. Piers 33 to 40 are precast girders, and there were limited retrofit measures required at these spans.

Structural Feasibility of the Proposed Shared Use Pedestrian-Bicycle Facility

The key structural considerations are as follows: additional loads, strength and serviceability, geometric requirements, proposed tube concept. Initial assessment results for each of the identified key structural considerations are discussed below.

Additional Loads

A preliminary analysis of the additional permanent, transient and total loads for the pedestrian bridge expressed as a percentage of the existing loads on the bridge is summarized as follows:

- Increase permanent (dead) loads 2 to 4 %
- Increase transient (live loads) 32 to 36 %
- Increase total loads 4 to 8 %

The increase in dead load is relatively small, while the increase in live load is significant. This is typically the case as special event loadings due to pedestrian traffic can be much larger than vehicle loads, particularly on multi-lane bridges.

Strength and Serviceability

Seismic demand (extreme event) invariably governs the strength requirements for bridges in California, and this bridge is no exception. The retrofit modeling and analysis completed in 2000 did not address the serviceability, or the performance requirements for the bridge, under service loads.

As part of the next phase of the work, a load rating of the existing bridge should be completed, along with serviceability checks.

Geometric Requirements

The minimum criteria and expanded criteria concepts for the bicycle/pedestrian facility are based on Caltrans standards that have resulted in inside diameters for the proposed tube structure of 6.85 feet and 9.06 feet respectively (See Figure 22).

For structural purposes, the minimum criteria concept has an assumed outside diameter of 15 feet and the expanded criteria concept has an assumed outside diameter of 19.5 feet. These sections are based on the assumption that the vertical and horizontal clearance criteria are fully contained within the cross section. However, this can be modified by opening the top of the tube to increase the vertical clearance, which may also provide an improved user experience.

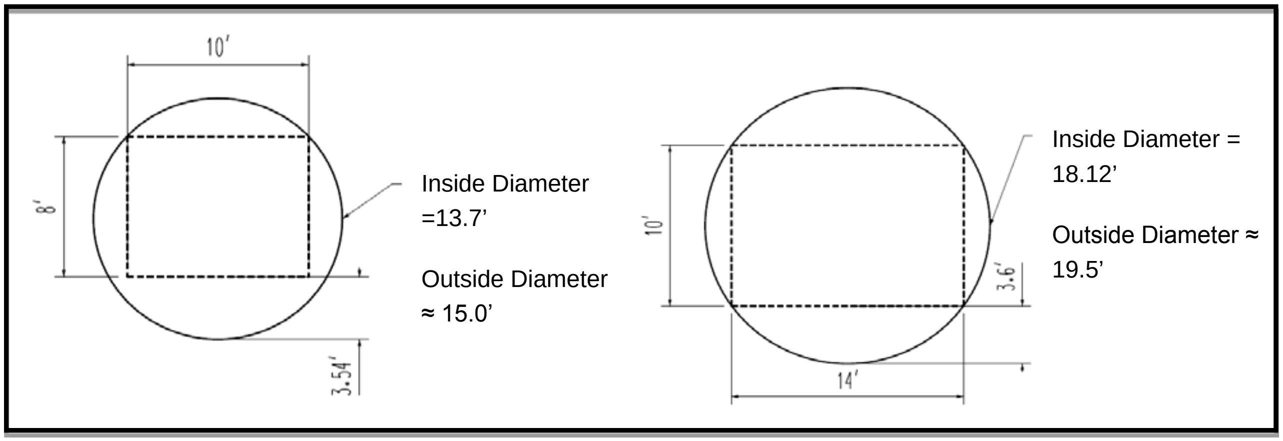

Figure 22: Minimum and Expanded Criteria Concept

Proposed Tube Concept

The architectural concept developed by domusstudio architecture is a ribbed tube supported at discrete locations from the existing bridge, with a structural deck element (as shown in Figure 9 previously). There are precedents for this concept elsewhere such as:

- The Calgary Peace Bridge in Calgary, Alberta, Canada;
- The Harbor Sky Path in Auckland, New Zealand; and,
- The T. Evans Wyckoff Memorial Bridge (Museum of Flight Bridge) in Seattle, Washington, United States.

A general rule the span-to-depth ratios for highway and pedestrian bridges is 30. This ratio can be extended up to 40 with the use of high performance steel and concrete, and even further extended by use of high-strength tendons. By implementing such an approach and developing a trapezoidal cross-section that is effectively a beam, the tubular concept can be preserved for architectural and aesthetic purposes, while the beam accommodates the bending, shear and torsion forces imposed by the anticipated spans.

A six foot deep trapezoidal box girder shape will efficiently span 180 feet, and can be extended up to a span of 240 feet. This would mean that the pedestrian structure can match the existing bridge spans up to 240 feet, resulting in a need for only 6 intermediate supports for the entire bridge length of 40 spans.

Support Options

In order to address the structural, aesthetic, and expected environmental needs, the team identified the following potential support options.

- Independent support utilizing separate columns and drilled shafts
- Support the structure using the existing bridge substructure or superstructure

For the Coronado and San Diego approaches, either option is feasible. For the main spans (Piers 18 to 21) it is likely that a tube facility will need to be supported from the existing superstructure.

Structural Conclusions:

- The existing bridge has been retrofit to modern standards
- The additional loads required by the proposed facility are not excessive, and may be able to be accommodated by the reserve capacity of the existing bridge but this must be confirmed by completing an existing bridge load rating analysis
- The in-service performance of the combined facility will need to be assessed in accordance with current criteria for pedestrian use
- Various support configurations for the approach spans and the main spans are feasible and practical

6. Constructability and Cost Opinion

Constructability

This section addresses the following considerations – facility access, bridge structure types, and access, as well as construction and materials technology.

Facility Access

Facility access is a critical aspect of the project because it impacts safety and security, as well as functionality and user comfort. The following access aspects are discussed in more detail below.

- Access
- Fire, Life and Safety

Access

For the purposes of this study, it was assumed that free-flowing access will be provided from grade from each end of the bridge. Free-flowing access requires an independent ramp structure that provides ADA compliant grades.

Fire, Life and Safety

As with any multi-use facility, fire, life and safety issues will need to be addressed. If emergency response and maintenance vehicle access is required from both ends of the bridge, which is most likely, security measures to limit access to authorized vehicles will be necessary. There will also be operational considerations associated with security measures to monitor activities on the facility such as patrols, closed-circuit television, call boxes, lighting and such, in addition to provisions to accommodate closing the facility during certain time periods should it be so desired.

Structure Zones, Types, and Access

There are several zones of structure type across the existing 11,000-foot alignment that will influence construction approaches and solutions. These zones are referred to as Connection, Divergent and Mid-Span zones for the purpose of this discussion.

In the Connection Zones at the east and west ends of the bridge, existing maintenance roads, bike paths, drainage swales, Section 4F properties, existing Right-of-Way (ROW), vertical clearance requirements, and existing rail (freight and local light rail) will all need to be considered. This will likely mean at-grade construction, independent structures, short spans, relatively small crane picks, and corresponding light-weight equipment.

The Divergent Zones are adjacent to the Connection Zones prior to touchdown where it may not be feasible to support the proposed facility on the existing bridge. In the Divergent Zones, it may be more cost-effective to design and construct independent substructures and foundations. If the construction occurs over water at the west end of the bridge, it will require a different construction approach than at the east end of the bridge where the divergence will occur over land. The divergent zone at Coronado will likely require low level access to the existing bridge over water between Piers 2 and 16, which may require conventional barge mounted cranes, and intermediate-weight equipment. The divergent zone on the San Diego end of the bridge will likely be similar to the Connection Zones, where overland construction should be relatively straight forward; subject to available right-of-way for construction activities, access to private property, and any noise restrictions that may be appropriate.

The Mid-Span Zone between Piers 16 and 23 will require high level access to the existing bridge in an over-water capacity and correspondingly heavier and costlier equipment. These requirements will drive support locations on the existing bridge, crane pick sizes, cost, and schedule. Construction in the mid-span zones will also need to account for and address the navigational needs and requirements of the U.S. Navy, U.S. Coast Guard, the Port of San Diego, and Caltrans.

In all zones, construction access, equipment size, construction phasing, and scheduling access and construction on the existing bridge will heavily influence risk, cost and schedule.

Construction and Materials Technology

A number of structural systems (such as a tube, girder, truss, etc.) and materials (such as concrete, steel, composites, etc.) are all considered potentially feasible for the construction of the proposed facility. The solution will have to be one that accommodates the intended function, provides an acceptable aesthetic, consists of readily available materials, is relatively easy to construct (prefabricated, modular, etc.), provides an acceptable service life with a reasonable level of maintenance, and that can be completed for the established project budget.

Construction, Engineering and Program Cost Opinion

An initial cost opinion for the design and construction of the proposed facility was developed based on a variety of design and construction factors, and a review of comparable facilities. In addition, it is important to note that the feasibility of the proposed facility is based on a conceptual level of design and high-level assessment of the existing bridge, and as such, the cost opinion is also at a high-level and includes various assumptions based on limited information and design and construction uncertainties.

Construction Cost Opinion

The construction cost opinion is based on a number of relevant factors, as well as industry per square foot costs for both typical and more complex bridge types, spans, and lengths. The following cost data was taken into consideration when developing the construction cost opinion for the proposed bicycle/pedestrian facility.

- Typical highway bridges (traditional girder spans up to the 400 foot range) cost between $300 and $500 per square foot.
- Highway spans in excess of 400 feet are typically accommodated by more complex structural systems (segmental concrete girders, arches, trusses, and cable-supported superstructures) resulting in per square foot costs up to $1,000 or more.
- Pedestrian bridges, even in the shorter span ranges (200 to 400 feet) can be very costly depending on the concept, the designer, the owner, architectural requirements/amenities including such cost drivers as touchdown configurations and viewing decks, and the political and regulatory environment. Costs for such facilities typically range from $300 to $600 per square foot on the low end to as much as $1,500 per square foot or more depending on some of the aforementioned considerations.

Given the considerations associated with the proposed facility as discussed in the preceding sections of this report (the circumstances of the existing bridge, the proposed structure complexity, and potential community expectations), it is felt that an initial construction cost opinion in the $500 per square foot or higher range is appropriate resulting in an approximate construction cost of $100 million.

A contractor-style constructability assessment and construction cost opinion was also obtained. That effort was based on construction approach (potential means and methods, equipment, labor needs, etc.) given the wide range of pier types, foundations, and super and substructure associated with the existing bridge. That effort result in an approximate direct construction cost of $105 million. It was felt that this value substantiated the square-foot-cost approach and given the more project-specific nature of this contractor-style approach, the $105 million dollar opinion is assumed for construction cost.

Programmatic Cost Opinion

Programmatic costs for complex and sizeable projects can be up to 40 percent of the design and construction cost depending on the complexity of the project. Programmatic costs typically include but are not necessarily limited to the following:

- Agency Administration
- Agency Design Review
- Public Involvement
- Construction Management

Rough-Order-of-Magnitude (ROM) Cost Opinion

Considering the complexity of the design requirements, complexity of construction means and methods associated with the existing bridge facility and over-water construction, as well as the conceptual nature of this study (i.e., the design and construction uncertainties), as shown in Table 1 the rough-order-of-magnitude cost opinion is estimated between $185M and $210M in 2015 dollars.

Table 1 – Rough Order of Magnitude Cost Opinion Summary (2015 dollars)

Cost Category	Low Range	High Range
Design	$18,000,000	$20,000,000
Construction	$102,000,000	$118,000,000
Contingency (Design & Construction Uncertainties)	$43,000,000	$48,000,000
Programmatic Costs	$22,000,000	$24,000,000
Total	**$185,000,000**	**$210,000,000**

7. Additional Considerations

Aesthetics Assessment

The domusstudio architecture concept for a new shared–used path was to create a tubular structure that is placed within the mission arch of the concrete towers under the steel girders, and place it on either side of the roadway deck at the main spans over the navigational channel. The desire for this concept is to have it be integral to the existing bridge and not drastically alter the aesthetic appearance of the existing award winning bridge. The concept was awarded the Best Unbuilt Project from the American Institute of Architects – San Diego Award Program in 2013, with the following jury comments:

> " A visionary proposal that lightly graces a massive and powerful iconic bridge (designed by San Diego legend, Robert Mosher) with a beautiful, serpentine structure insinuating itself within the mass without fanfare while promising to transform a vehicles-only connector into a multi-modal conduit with the potential to transform communities on both sides of the channel it traverses. A guide for future thinking about humanizing transportation planning."

The new bicycle/pedestrian shared–used path must therefore be an aesthetic and pleasing design that complements and integrates gracefully with the iconic Coronado Bridge. Whether this will be a circular tube, truss structure or an open expanded deck, it must appear to be an integral part of the bridge, not an appendage. Careful consideration needs to be given to the appearance of the new structure in relationship to the bridge; including coordinating materials, finishes, and colors that with blend in with the existing bridge. Overlooks at key areas, such as at the main span, will require aesthetic treatments for users to gather and enjoy the view, and key appurtenances will be required. Aesthetic treatments at the connection of the approaches of the bridges to the trails on the Coronado side as well as to the pedestrian sidewalks and bike lanes on the San Diego side will need to be considered.

The proposed concept has an elegant solution in keeping the tube structure within the arches of the pier cap, and having the alignment be a "beautiful, serpentine structure" within the pier structures, but the required width for the share-used path placed in the tubular structure to fit within the pier cap "arches" may be comprised, and ultimately require placement below the "arch". The placement of the alignment within the piers offers a design that follows the symmetry of the bridge to fit it aesthetically, but the requirement to remain clear of the navigational channels requires steeper slopes and landings. An alignment higher than the pier arches, aligned with the bottom of the main span girders or level with the current roadway deck, could achieve the ADA slope and still follow the flow of the deck structure.

The final preferred alignment, whether the tube within the piers or to the side of the deck, will need to be seen as an elegant solution that complements the existing award-winning bridge, that blends in with the bridge and uses materials and finishes that allow the structure to be an extension of the bridge and not dominate it. The structural system to carry the alignment needs to appear to be an extension of the bridge and not a retrofit that would potentially mar the bridge aesthetics or compromise the structural integrity of the existing bridge structure, which already has been retrofit to seismic requirements. Likewise, the proposed new shared-path must be structurally sound, yet offer its users a unique experience of being on the bridge as a bicyclist or pedestrian.

Safety and Security Assessment

The Team used the Caltrans HDM and the Caltrans DIB to develop a conceptual design for the proposed facility that complies with the identified design requirements for a bicycle/pedestrian path on a structure, which provides the base component for public safety from a facility design standpoint. However, additional interaction and coordination with local agencies, jurisdictions and law enforcement is required to fully understand the safety and security measures required and desired by 1st responders. It is expected that the following Public Safety items will be important to address with Caltrans, first responders from the City of San Diego and City of Coronado, and the California Highway Patrol.

1) Closure of Facility and Use During Hours of Darkness – security/locking of access ramps/elevators (if provided).
2) Emergency Access – the facility must be accessible in case of emergency or incident. This could be via the proposed facility by motorized means (vehicle, golf cart, motorcycle, etc.) or via the bridge deck if the facility were located adjacent to the roadway.
3) Suicide Deterrent – facility design that prevents or significantly limits the ability to gain access to the exterior of the structure. There may be the potential for the facility to be designed in coordination with a suicide deterrent system for the bridge (netting, fencing, or other means).

In addition to the above Public Safety components to be reviewed and assessed, the facility design and operational components also need to consider the requirements and restrictions imposed by the Port of San Diego, the U.S. Navy and Homeland Security for facilities spanning an active navigation channel, which expressly restricts encroachment into the designated navigational channels. As noted earlier, the initial concept was found to encroach on the navigation channels, whereas the two alignment alternatives (along-side the superstructure or along-side the bridge deck) can be designed to span the navigation channel without encroachment. It is expected that each of the noted agencies would identify, among others, the following concerns:

1) Falling Objects – Protection from errant or thrown items from the proposed bicycle/pedestrian facility.
2) Navigational Channels – Design features that restrict any materials from being suspended from the proposed facility, any blockage or obstruction of ship traffic.

Finally, safety and security concerns of the users of the bicycle/pedestrian facility, roadway and bridge automobile travelers, and water-based travelers below the proposed facility should also be considered and explored. The anticipated safety and security concerns of the users of the facility, adjacent/connecting roadway users, and water-based travelers are listed below and should be addressed in future planning and design phases.

Users of the proposed bicycle/pedestrian facility safety and security considerations:

1) Access to the Facility – comfortable street access locations, design of the access ramps for ease of use, potential stair and elevator access.
2) Travel on the Facility –sight-lines, obscured corners and visibility, adequate space for both pedestrians and cyclists, protection from traffic/roadway debris.
3) Safety and Security Needs – lighting, emergency call/radio boxes, video detection/monitoring, walking patrols or other security personnel.

Adjacent roadway and bridge automobile travelers' safety and security considerations:

1) Roadway Access Locations – Auto/bicycle/pedestrian Interaction at access locations (adequate space for users to enter/exit the roadway and connect to ramps/stairs/elevators, sight lines to access points if entering exiting via roadway.
2) Bridge Travelers – protection from errant or thrown items from the proposed facility (if adjacent to bridge deck travel lanes).

Water-based travelers' safety and security considerations:

1) Falling Objects – Protection from errant or thrown items from the proposed bicycle/pedestrian facility.

8. Conclusion and Next Steps

Based on the review and high-level analysis completed for the feasibility assessment – it is the Team's opinion that the addition of a bicycle/pedestrian facility to the Coronado Bay Bridge is not fatally flawed. However, a number of challenges associated with the concept were identified and are summarized below.

Alignment and Geometric Assessment

The team identified three potential alignment alternatives that could potentially accommodate a bicycle/pedestrian structure at various locations on the existing bridge structure – under the pier archway, alongside the pier caps and adjacent to the bridge deck. Each of the identified alignments presents challenges. The high-level assessment of the alignment alternatives and the major challenges of each alignment are summarized below:

- Pier Archway – The initial concept was developed to take advantage of the center archways of the bridge pier in order to preserve the architectural and aesthetic principals of this iconic bridge. The initial concept is for a tube-type structure to be located primarily within the center archway of the Coronado Bridge piers and also provide users with the opportunity to enjoy the commanding views that the structure would provide. In order to provide observation decks on the north and south side of the bridge, the facility would swing out from under the center arch, transitioning the alignment to the southern side of the bridge, and then transition back to the northern side of the bridge. The Pier Archway alignment is able to maintain the ADA grade requirements of 5 percent grade or less within the pier archway location for a majority of the bridge span. However, maintaining the 5 percent grade results in the alignment infringing on the navigational channel, with the structure being located below the required 197.12 foot clearance.

- Pier Cap – The pier cap alignment option would locate the potential bicycle/pedestrian facility at the approximate level of the bridge pier caps. This option would only allow a viewing platform on one side of the bridge and would also conflict with the existing traveler system used to maintain the bridge. This would require a new traveler maintenance system to be designed and constructed.

- Bridge Deck – The third alignment identified by the team placed the bicycle/pedestrian facility alongside the roadway bridge deck. Like the pier cap location, this alignment could be placed on the north or south side of the bridge, only allowing a viewing platform on one side. While this alignment alternative is expected to provide the easiest touchdown connection opportunities, placement of the structure adjacent to the bridge deck would obstruct views of motorists on the bridge and may impact the overall aesthetics of this iconic bridge.

Finally, an option to adjusting the alignment of the proposed facility would be to adjust the overall design of the facility from a fully enclosed, circular shape to a partially enclosed circular shape, or a different shape that more efficiently provides the necessary geometric standards and requirements for a bicycle/pedestrian facility.

Structural Assessment

The high-level analysis completed to assess the structural feasibility of accommodating the proposed bicycle/pedestrian facility on the existing San Diego – Coronado Bay Bridge indicated that the concept appears feasible. However, as with the geometry and alignment, while there were no identified fatal flaws, there are challenges associated with adding the proposed facility – structural composition of the tube concept, connection to and support of the facility from the existing bridge, and interaction of the two structures for static and transitory loadings (thermal, seismic, wind, dead and live loads).

While the identified challenges are not considered to be fatal flaws or insurmountable, they do require additional study to fully vet the structural concept and identify strengthening measures required to accommodate the final structural configuration and facility alignment.

Constructability and Cost Opinion

Similar to the assessment for the alignment, geometry and structural feasibility – the team did not identify any fatal flaws for constructability and cost, but there are challenges associated with the construction of the proposed facility. As noted earlier, the span arrangement of the Bridge is very diverse, which influences the construction approach and potential solutions, and as a result introduces greater variability in assumed construction means and methods. In addition, the required over-water construction (at a considerable height in considerable portions), as well as the need to maintain/address the navigation needs and requirements of the U.S. Navy, U.S. Coast Guard, and the Port of San Diego complicates construction of the conceptual facility. All of these considerations present a complex construction environment that requires further analysis to adequately identify the necessary construction approaches (potential means and methods).

The team developed a high-level, conceptual cost opinion based on a number of relevant factors, such as contractor means and methods, industry per square foot costs, and costs considered typical for both standard and exotic bridge spans. Taking into account the existing bridge and proposed structure complexity, community expectation, programmatic costs and other unknown factors at this juncture – a high-level, ROM opinion of total capital expenditure to construct the proposed bicycle/pedestrian structure is between $185 and $210 million.

Next Steps

Based on the initial ROM cost opinion, an initial step to determine financial feasibility would be to assess available federal, state, and local funding sources, grants, and programs, private grants and funding sources, or the potential for the facility to self-fund some cost component, such as maintenance, through the use of tolls. While this study evaluates a specific bicycle pedestrian concept (tube structure located at various locations) the next step would be to initiate additional high-level planning studies to define the purpose and need, identify and assess a wide-range of crossing methods and technologies, environmental and permitting requirements, additional structural analysis, and safety, operational and maintenance considerations associated with the potential facility structure (Appendix B Caltrans response). The Coronado Bridge Suicide Prevention Collaborative, a non-profit organization, is currently applying for a grant to fund a feasibility study that would evaluate a suicide prevention barrier on the Coronado Bridge. Additional studies or evaluations should also take the inclusion of a suicide barrier into consideration.

Appendix A –Department of the Navy

DEPARTMENT OF THE NAVY
COMMANDER NAVY REGION SOUTHWEST
937 N. HARBOR DR.
SAN DIEGO, CA 92132-0058

IN REPLY REFER TO:

4730
Ser N00/171
February 3, 2016

Supervisor Greg Cox
San Diego County Board of Supervisors, District 1
County Administration Center
1600 Pacific Highway, Room 335
San Diego, CA 92101

Dear Supervisor Cox:

Thank you for the opportunity to provide Navy comment to the Coronado Bridge Bicycle/Pedestrian Feasibility Study. In concept, the Navy community in the metro San Diego area would benefit greatly from the ability to bike, or use as a pedestrian walkway, between San Diego and the City of Coronado and sincerely support further analysis for the proposed project. While the Navy sees no current operational impact with options that do not hang below the current bridge structure, we cannot support any option which reduces current existing minimum clearance of 195 feet.

The National Oceanic and Atmospheric Administration (NOAA) Coastal Navigation Chart 1877 42nd Edition, dated January 2011 for San Diego Bay shows that the bridge span reaches a height of 195 feet above Mean High Water (MHW) tide level directly below the inbound vessel transit lane piers 18 and 19 and a maximum height of 214 feet below the outbound vessel transit lane piers 19 and 20. This height allows U. S. Navy ships operating out of Naval Base San Diego and civilian cargo vessels operating out of National City Marine Terminal as well as the NASSCO Shipyard to pass underneath the bridge within designated transit lanes. The largest Navy vessels to pass under the bridge are the four large-deck amphibious assault ships (LHA/LHD class vessels) homeported at Naval Base San Diego. These ships have a height above the waterline that reaches 192 feet, depending on ship type and mission load out configuration affecting the vessel's draft. Therefore any alternative of the proposed project which reduces the current minimum clearance of 195 feet between spans 18 and 20 would impede Navy vessel traffic and would not be supportable due to mission impact.

M. K. RICH

Appendix B –Caltrans

February 17, 2016

11-SD-75, PM 20.1/22.3, Br. #57-0857

Project ID 1115000155, EA 42180k

Background:
HNTB prepared a Feasibility Study for SANDAG, dated November, 2015 that proposed adding a bike path in a tubular structure along the Coronado
Bay Bridge. Three alternatives were considered along the CBB. These included a tube directly under the middle of the bridge, a tube on one side under the deck, and a tube on the outside of the bridge generally following the roadway.

Safety and Geometrics & Design:

1. The recommended nominal cross section width is 14 feet per Highway Design Manual (HDM) Chapter 1003.1 (1). Also vertical clearance for bikes is not less than 8 feet and preferably 10 feet per HDM 1003.1
2. Access to the bike tube should be considered for emergencies or accidents.
3. Will the path be open to pedestrians? If so, ADA guidance states that grades of 4.8 percent are permitted but rest or turn landings (5 foot x 5 foot) for every 30 feet of length are required. Handrails are required for ADA facilities at 36" to 38" above grade.
4. Will the bike tube be open 24/7 and/or would there be a gate or gates to close the tube?
5. Prevention of individuals climbing or accessing the outside of the bike tube would need to be considered, along with the potential for dropping of objects from the tube.

Maintenance:

1. This structure requires frequent painting and other maintenance. Access around the bike tube would be required and improvements/modifications to the existing maintenance 'traveler' would be needed.
2. The electrical utility infrastructure is expected to be replaced along with the existing bridge lighting. The bike tube would require its own lighting and possibly an independent communication system.
3. Existing navigation equipment such as a fog horn and beacons would need to be avoided or relocated. Future access to these facilities is required.
4. The bike path would need to drain, and not pool water and minimize cross flow for safety purposes.
5. Consideration of cleaning the bike surface is needed.
6. Impacts to maintenance access and operations of the CBB would need to be considered during design of the bike tube. A future maintenance agreement would be needed

between Caltrans and the project sponsor/agency to determine the appropriate entity to fund and provide maintenance of the Bike/Ped facility. This would include Graffiti removal as well.

Right of Way:

1. Alignments along the east end would generally cross into Chicano Park. A southern alignment would put the along Dewey Street. These alignments would require R/W agreements with the City of San Diego.
2. The Harbor Drive alignment appears to be in the median of Harbor Drive, Chapter 1000 of the HDM does not allow bikeways in the median of a roadway.
3. The CBB R/W limits currently extend approximately 15 feet outside of the edge of the bridge deck on the Port District property Bike tube alternatives along the outside edge extend beyond the existing R/W. Coordination with the Port District would be needed.

Environmental:

1. An EIR/EIS would be required for the project. Caltrans could act as the lead agency.
2. A visual analysis would be required for any project that could change the appearance or aesthetics of the bridge. A Visual Impact Analysis (VIA) would need to be prepared. Measures to minimize and mitigate would need to be addressed in the VIA.
3. Extensive community outreach, through a Community Outreach Plan and Community Impact Assessment would be need.
4. US Fish and Wildlife and CA Fish and Wildlife permits may be required for construction and access near eelgrass.
5. Chicano Park, is underneath the east end of the bridge. Special care would be needed to address possible impacts to the Park. Impacts would likely be considered 4(f) and coordinated with the City of San Diego
6. At the west end of the bike path is Tidelands Park and the Coronado Municipal Golf Course. Coordination with the City of Coronado would be need for Tidelands Park and/or municipal golf course Impacts.
7. Storm Water Pollution Prevention plan ((SWPP) and Storm Water Data Report (SWDR) would need to be prepared to address water quality issues.
8. The bridge will meet a 5 years threshold in 2019 for National Register of Historic Places (NRHP). Both HQ and State Historic Preservations Offices (SHPO) would need to concur for any changes to the Bridge.
9. Other environmental factors would be reduction of green-house gases, VMT and vehicular congestion.

10. Because the bridge is over the "waters of the US" the U.S. Army Corp of Engineers may would need to be involved.
11. California Coastal Commission would be involved.
12. Potential Permits/Permissions to be considered in the design:

Potential Permits/Permissions:	Jurisdiction
Coastal Zone	Local/State
Harbor	Local
Coast Guard	Federal
CHP	State
US Fish & Wildlife	Federal
CA Fish & Wildlife	State
Navy	Federal
US Army Corp of Engineers	Federal
Homeland Security	Federal
City of San Diego	Local
City of Coronado	Local
Port of San Diego	Local
State Historic Preservation Office	State

Structures:

1. Eccentric loading would need to be analyzed if the bike path were attached along the side of the bridge super structure.
2. Normal bridge loading movements would prohibit welding, and an analysis of the bike path connections to the bridge would need to be evaluated.
3. The bike path would need to be able to flex with the bridge for normal dynamic loads, wind and thermal stresses as well as for seismic events.
4. The existing bridge superstructure and substructure should be modeled and analyzed. Analysis assessments should show that the structure components (superstructure, substructure, and foundation) have adequate capacities for the added bike tube dead loads and service loads (e.g. live loads- bike and pedestrians, wind loads, thermal, and etc.).
5. The effects of the bike tube vibration induced by wind, bike and footsteps, etc. should be assessed and evaluated for any vibration resonance effects to the existing bridge.
6. The bike tube may form a complicated wind channel, wind effects on the combined structure (by means such as wind tunnel modeling) may need to be investigated.

7. The combined structures of the added bike tube and the existing bridge should be analyzed in accordance with the current Caltrans Seismic Design Criteria, including column and pile Ductility-Demand (D/C) ratios.
8. The bike tube design should consider the conceptual details for expansion joints.
9. The bike tube design should assess and address structure constructability issues, such as access, staging and traffic handling plans.

Traffic operations:

1. The bike path design needs to address the ingress/egress traffic operations. (See note 2 in the Right of Way Section) The design needs to include striping details, signage, and bike and/or pedestrian signals.